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# SOURCE CONTRIBUTIONS TO TSP NON-ATTAINMENT FOR THE ADAMS, WASHINGTON, AND COOLEY HI-VOL SITES IN CHICAGO, ILLINOIS

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SOURCE CONTRIBUTIONS TO TSP NON-ATTAINMENT  
FOR THE  
ADDAMS, WASHINGTON, AND COOLEY HI-VOL SITES  
IN CHICAGO, ILLINOIS

by

IIT Research Institute  
10 West 35th Street  
Chicago, Illinois 60616

Project No. 10.084

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State of Illinois  
Department of Energy and Natural Resources  
Division of Environmental Management  
309 West Washington Street  
Chicago, IL 60606

## NOTE

This report has been reviewed by the Department of Energy and Natural Resources and approved for publication. Views expressed are those of the contractor and do not necessarily reflect the position of the ENR.

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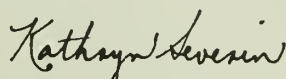
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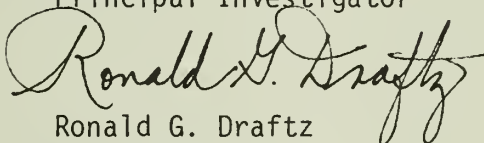
## FOREWORD

This is a final report on the identification of sources contributing to TSP non-attainment at selected sites in Chicago, Illinois. This report is submitted in partial fulfillment of ENR Project No. 10.084. Mr. William J. Murphy of ENR served as Project Director. This project was conducted by members of the Fine Particles and Analytical Chemistry Research Sections of IIT Research Institute.

Respectfully submitted,  
IIT RESEARCH INSTITUTE




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Ref.: C08564

## ACKNOWLEDGEMENT

Mr. William J. Murphy of the Department of Energy and Natural Resources, who served as Project Officer for this study, and Mr. John Schrock of the Illinois Environmental Protection Agency, performed an extensive review of the report in its draft form. Their many suggestions added substantially to the form and content of this report which the authors greatly appreciate.

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## 1. EXECUTIVE SUMMARY

Provisions of the Clean Air Act (1977) require States to revise their State Implementation Plans (SIP) for all areas that have not attained National Ambient Air Quality Standards. The Illinois SIP for Total Suspended Particulates (TSP) was conditionally approved by the U.S. Environmental Protection Agency with certain minor deficiencies. One of those deficiencies was incomplete documentation of the impacts from non-traditional fugitive sources of TSP and the effects of various control strategies. Examples of these non-traditional TSP sources include reentrained road dust, wind erosion from agricultural lands, and unpaved road emissions. This and similar studies have been designed to correct those deficiencies and will be submitted to the U.S. Environmental Protection Agency as part of the SIP.

The results of these studies will be used by IEPA to further define the estimated impacts from non-traditional fugitive dust sources on TSP non-attainment areas throughout the State. The studies will also be used to refine control strategies which may need to be applied to various non-traditional fugitive dust sources. This study was funded by the Division of Environmental Management of the Department of Energy and Natural Resources.

A total of 37 hi-vol filters collected during 1979 at three TSP non-attainment sites in Chicago--Cooley High School, Washington High School, Addams Elementary School--were analyzed to determine the sources contributing to the TSP non-attainment status at these sites. The methods used for filter analysis included polarized light microscopy for particle speciation and source identification, ion chromatography for sulfates and nitrates and low temperature ashing to determine the mass fractions of organic and inorganic aerosols.

The Cooley High School site is located approximately 2 miles northwest of downtown Chicago in a high-density residential neighborhood, adjacent to three major arterials. There are no major point sources within 5 km of the site. The primary component contributing to TSP concentrations that exceeded  $75 \mu\text{g}/\text{m}^3$  was carbonate aggregate minerals, primarily calcite, suspended from roadways by traffic. The four days with the highest TSP concentrations had carbonate

concentrations ranging from  $53 \mu\text{g}/\text{m}^3$  to  $88 \mu\text{g}/\text{m}^3$ . Soil minerals, primarily quartz and clays, also had a dominant impact on TSP concentrations, contributing from  $26 \mu\text{g}/\text{m}^3$  to  $103 \mu\text{g}/\text{m}^3$  for the same four, highest TSP days. The source of these soil minerals is also believed to be due to entrainment by traffic or construction rather than wind erosion. Secondary inorganic aerosols, ammonium sulfate and ammonium nitrate were the third largest category, contributing  $18 \mu\text{g}/\text{m}^3$  to  $31 \mu\text{g}/\text{m}^3$  to TSP concentrations. Primary industrial emissions consisted of magnetic oxide fragments and glassy flyash, from different sources. The combined concentrations of these industrial emissions varied from  $1 \mu\text{g}/\text{m}^3$  to  $46 \mu\text{g}/\text{m}^3$ .

The Washington High School site is located on the far southeast of Chicago and is bordered to the north and east by residential neighborhoods, and to the southwest and west by two major steel plants within  $1\frac{1}{2}$  km from the site. A third mill (Wisconsin Steel) was also operating during 1979, but is currently closed. Five of the eleven samples had TSP concentrations exceeding  $260 \mu\text{g}/\text{m}^3$ , the NAAQS 24-hour TSP standard. These five samples plus two others with TSP concentrations in excess of  $100 \mu\text{g}/\text{m}^3$  were dominated by steel industry emissions, principally in the form of magnetic iron oxides. One sample (TSP =  $398 \mu\text{g}/\text{m}^3$ ) had a steel impact of  $227 \mu\text{g}/\text{m}^3$ , while the lowest steel impact was  $18 \mu\text{g}/\text{m}^3$  (TSP =  $55 \mu\text{g}/\text{m}^3$ ) among all the samples. Minerals categorized under traffic-generated dusts generally had a high correlation (+0.82) with industrial emissions, suggesting that a significant portion of the minerals were emitted from within or near the steel mill sites. With the exception of the combined ammonium sulfate/ammonium nitrate contribution ( $33 \mu\text{g}/\text{m}^3$  average,  $8 \mu\text{g}/\text{m}^3$  to  $80 \mu\text{g}/\text{m}^3$ ) there was little impact from other generic sources.

The third site, Addams Elementary School, has an exposure similar to Washington High School and a similar cause of high TSP concentrations. The Addams school is located approximately 1.3 km north and 0.5 km east of Washington High School. While the Addams school is completely surrounded by a dense, residential neighborhood, it is just several kilometers from the same steel mills that impacted Washington High School. Seven of the eleven Addams samples submitted for analysis had TSP concentrations that exceeded  $100 \mu\text{g}/\text{m}^3$ , ranging from  $109 \mu\text{g}/\text{m}^3$  to  $230 \mu\text{g}/\text{m}^3$ . The corresponding steel mill impact ranged from

29  $\mu\text{g}/\text{m}^3$  to 160  $\mu\text{g}/\text{m}^3$  with an average of 81  $\mu\text{g}/\text{m}^3$ . The minerals content of these samples varied from 23  $\mu\text{g}/\text{m}^3$  to 92  $\mu\text{g}/\text{m}^3$ . Sulfate and nitrate concentrations were significant, amounting to an average of 45  $\mu\text{g}/\text{m}^3$  from a range of 25  $\mu\text{g}/\text{m}^3$  to 77  $\mu\text{g}/\text{m}^3$ . On one day, pulverized coal flyash emissions added 30  $\mu\text{g}/\text{m}^3$  to the TSP concentration (200  $\mu\text{g}/\text{m}^3$ ). In most samples, the composition, and therefore the sources of aerosols, were the same at the Washington and Addams sites.

Figures 1, 2 and 3 graphically summarize the generic TSP source categories found in each sample.

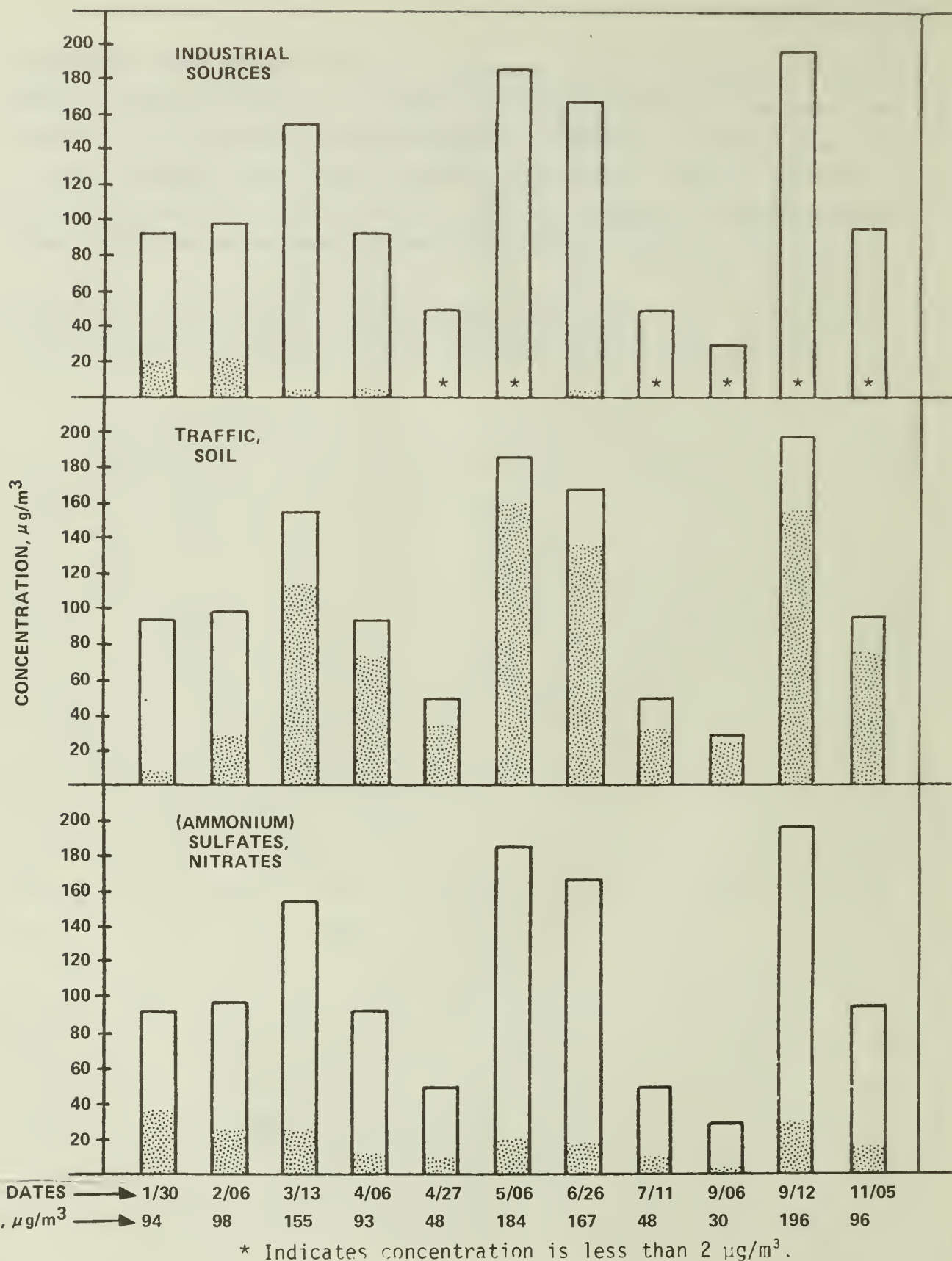


Fig. 1 SUMMARY OF SOURCE CONTRIBUTIONS TO TSP AT THE COOLEY SITE

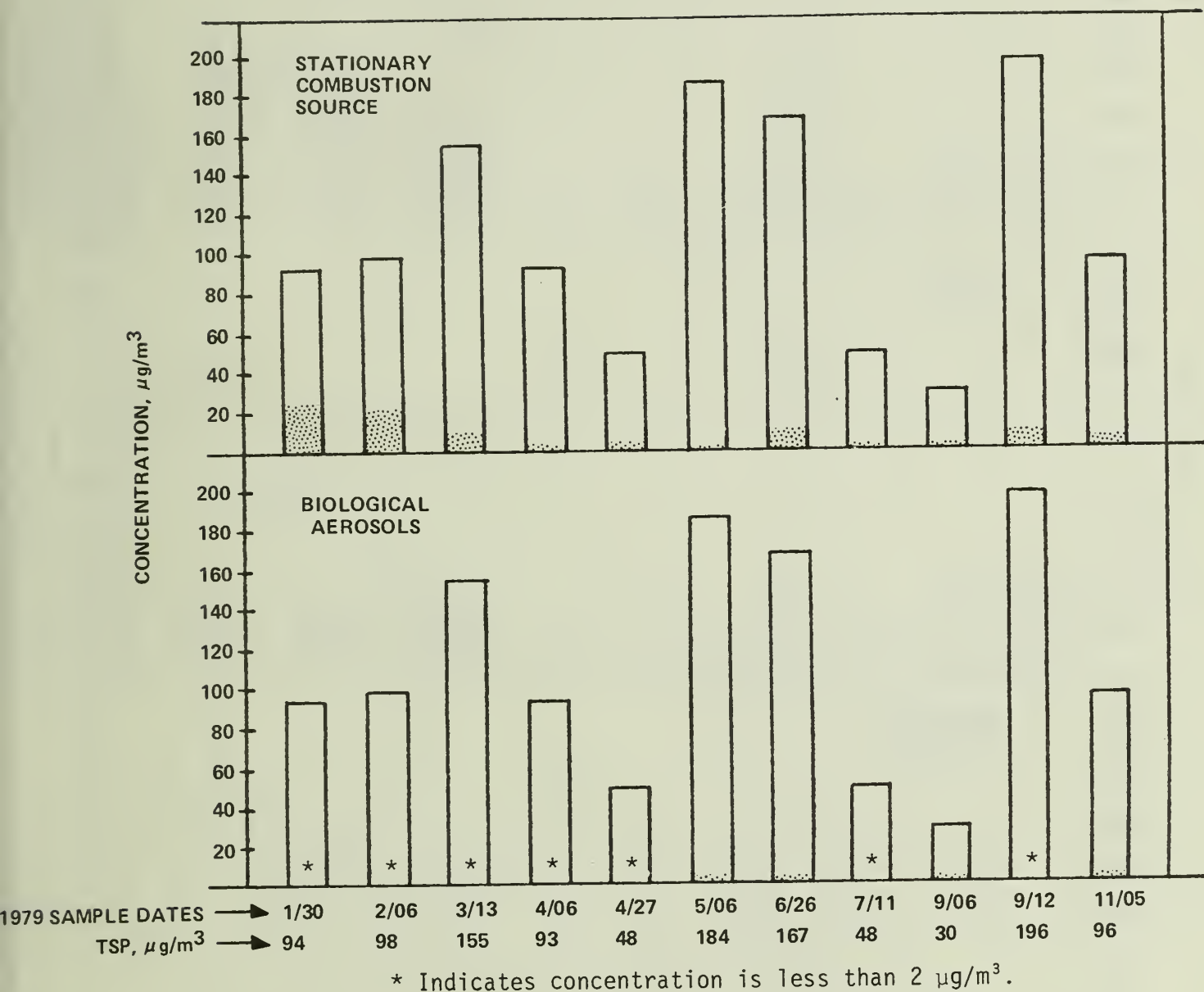


Figure 1 (CONTINUED)

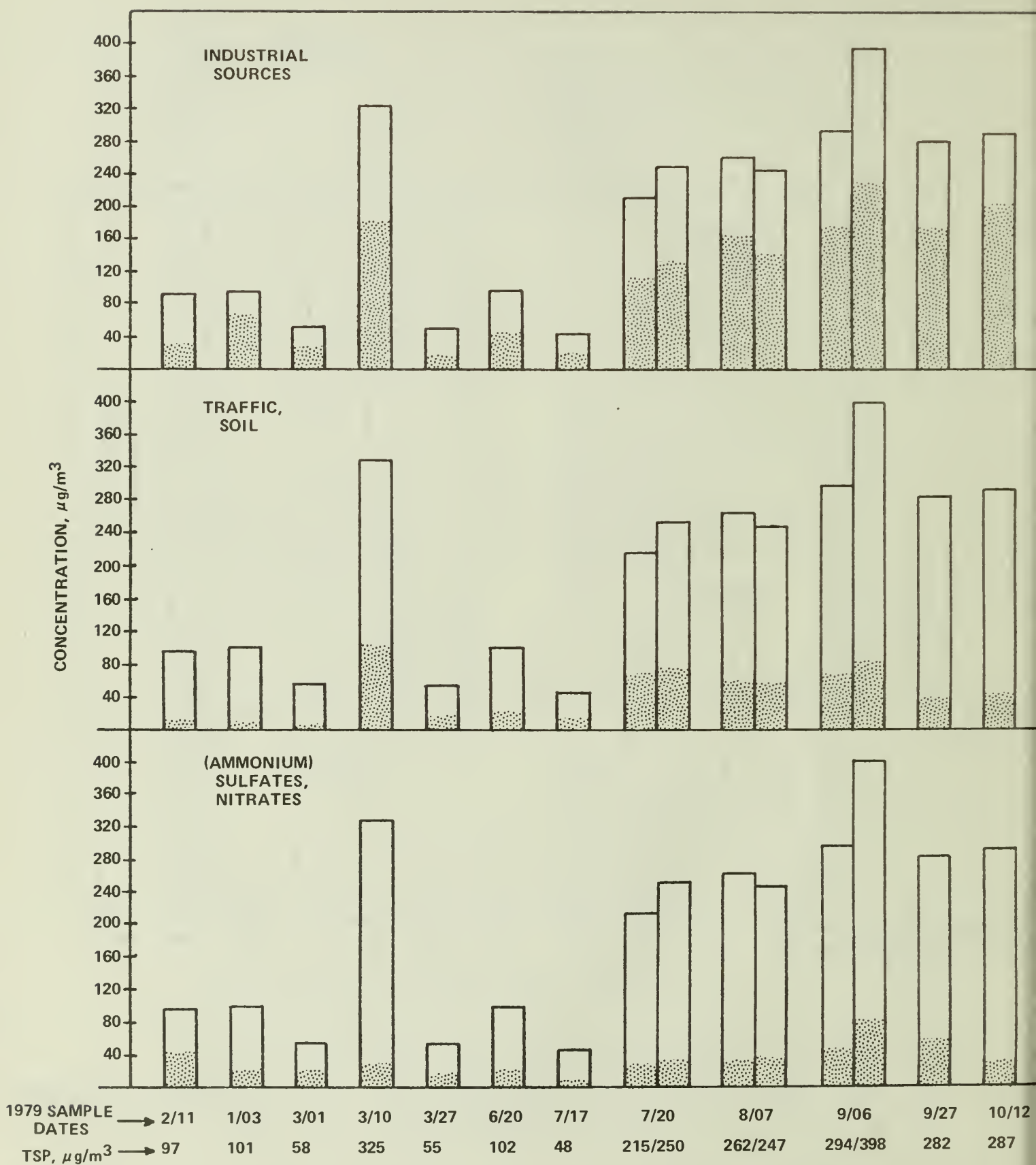


Fig. 2 SUMMARY OF SOURCE CONTRIBUTIONS TO TSP AT THE WASHINGTON SITE

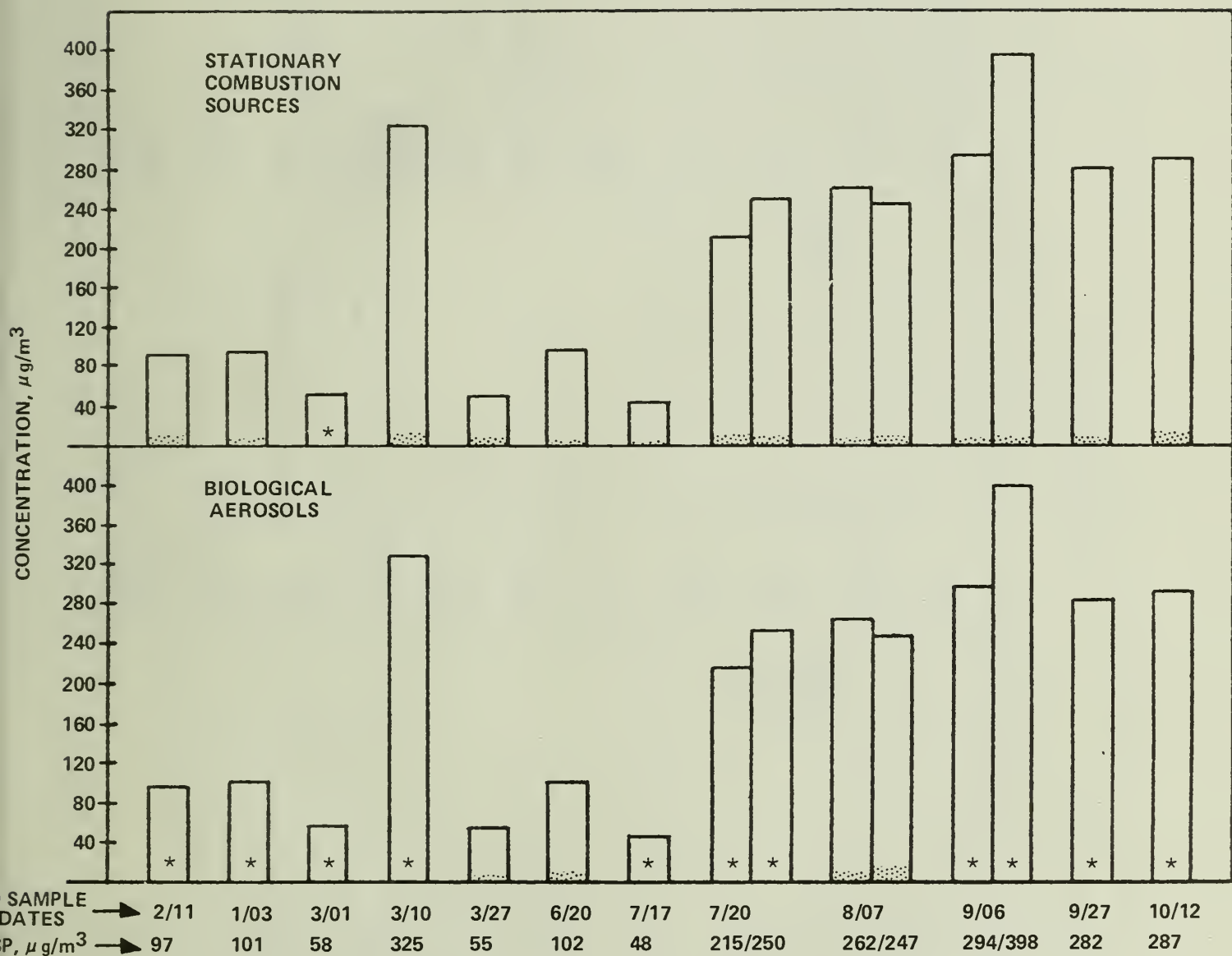


Figure 2 (CONTINUED)

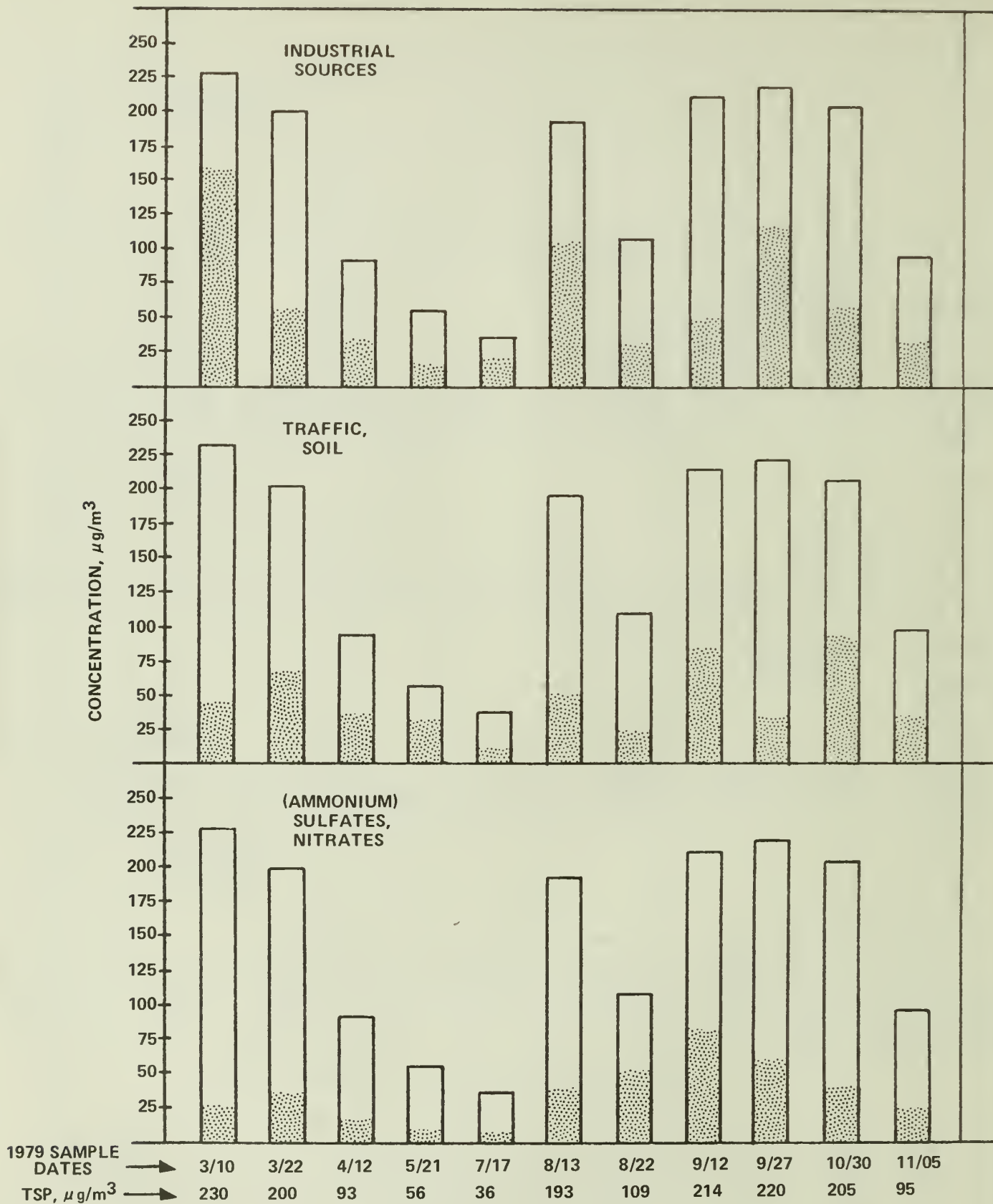


Fig. 3 SUMMARY OF SOURCE CONTRIBUTIONS TO TSP AT THE ADDAMS SITE

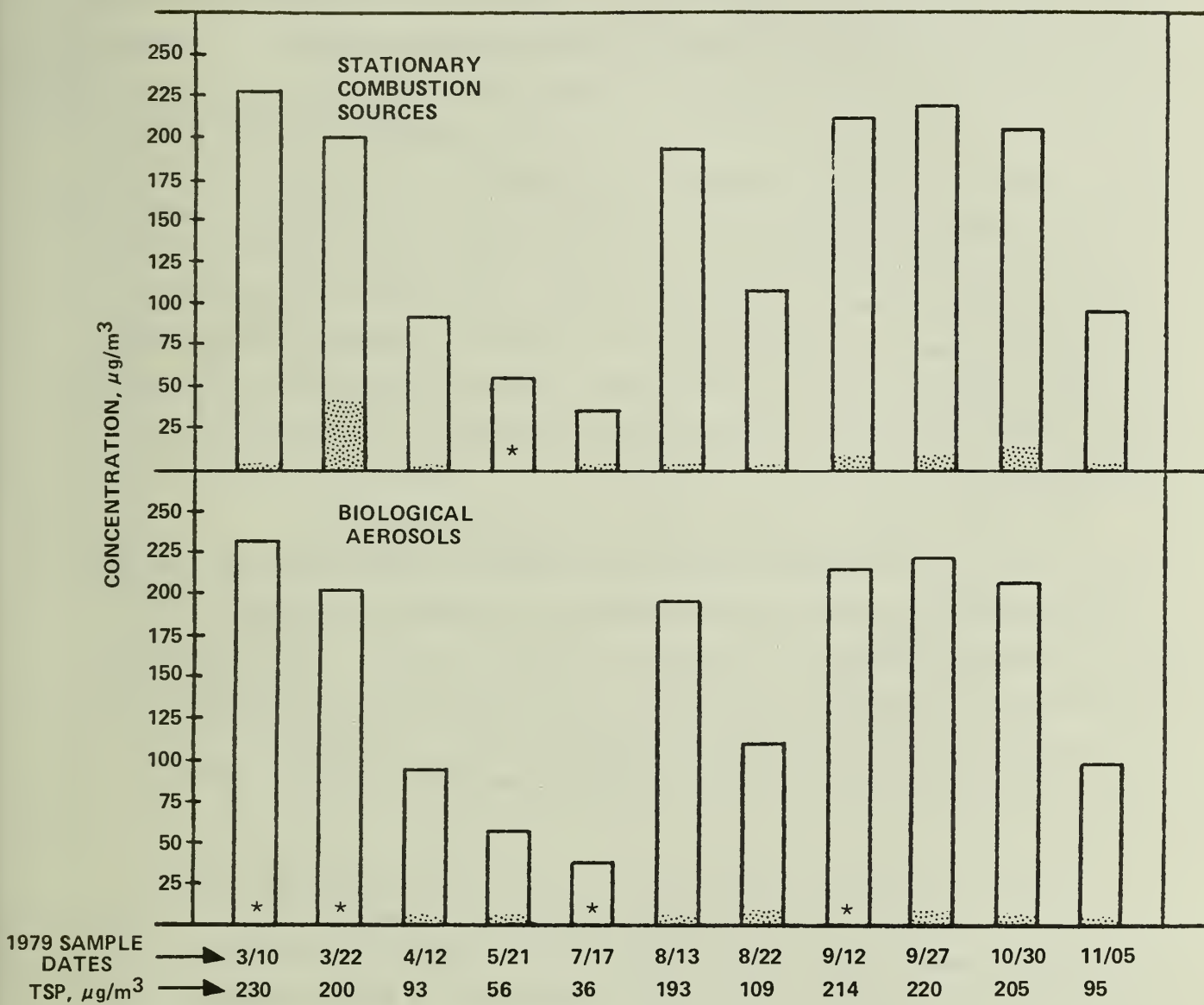


Figure 3 (CONTINUED)

## 2. INTRODUCTION

The current National Ambient Air Quality Standards (NAAQS) for atmospheric aerosols are based on mass concentrations per unit volume of air without regard to particle size or composition. While reduction in concentrations of atmospheric particles is desirable from health and economic aspects, it is becoming increasingly evident that the current standards may not adequately address the health aspects of airborne particles. It is now recognized that a significant mass fraction of the TSP is outside of (larger than) the particle size ranges which are inhalable and respirable. Therefore, revised national air particulate standards are being considered which will more specifically address the health impact of inhalable and respirable particles. Formulation of these revised air particulate standards requires data on the particle sizes and particle types currently comprising the TSP. These data will not only provide a better assessment of health risks but will also provide insight for the development and implementation of new control strategies by each state.

The Illinois DENR, formerly IINR in conjunction with the Illinois Environmental Protection Agency (IEPA) have formulated and sponsored a number of research studies which address the current TSP problem. The goal of this research study was to determine the sources which contribute to the TSP problem in three TSP non-attainment sites in Chicago. Data gathered from this study will be used to evaluate current control strategies at these sites and will also serve as a basis for reviewing possible changes in control strategies necessitated by revised federal standards.

A total of 37 high-volume (hi-vol) filter samples were selected by the Illinois Environmental Protection Agency from those samples collected by the Chicago Department of Consumer Services and submitted to IITRI for analysis. Microscopical and chemical analyses were performed to determine aerosol composition and concentrations. These analyses were coupled with meteorological data, and with microinventory surveys to identify the most probable sources contributing to the TSP problem.

### 3. FILTER ANALYSIS METHODS

The primary method of determining aerosol composition and concentration was through polarized light microscopy. Water soluble sulfates and nitrates were analyzed by ion chromatography. Low temperature (<200°C) plasma ashing was used as a method to determine the mass fraction of inorganic and organic aerosols. A complete description of the techniques appears in Appendix A.

#### 3.1 ANALYTICAL RESULTS

The complete results for each filter sample is presented on individual data sheets in Appendix B. A tabulation of these results are summarized for each site in Tables 1, 2 and 3. Tables 4, 5 and 6 present the same results expressed as weight percent by category. Results for water soluble sulfate and nitrate are presented in Table 7. Meteorological data are presented in Table 8, with the caveat that wind directional data may not be appropriate for the sampling sites in this study since they are all more than 10 miles from the meteorological station.

#### 3.2 PARTICLE DESCRIPTIONS AND SOURCE ASSIGNMENT RATIONALE

A list of the more commonly encountered aerosol types are shown on an example data sheet, Figure 4. Aerosol components are grouped by generic source ("Mobile", "Combustion") or by composition ("Minerals, Biologicals") if a source is not directly indicated by aerosol morphology. The "Miscellaneous" category contains less frequently encountered aerosols that are generally associated with fugitive, industrial sources.

Mineral components are generally the dominant constituents of the TSP burden. Mineral sources are frequently roadway dusts. The chief emission products from paved roadways are limestone fragments (calcite and/or dolomite) where limestone is used as the pavement aggregate in asphalt roads. These limestone aerosols are generated by erosion of the pavement aggregate and suspension by vehicles. Limestone is also used as aggregate on unpaved roads and in commercial and industrial parking lots. Finally, limestone has a wide variety of industrial uses including cement and steel making.

*(text continued on page 24)*

Table 1  
SOURCE CONTRIBUTIONS TO TSP CONCENTRATIONS,  $\mu\text{g}/\text{m}^3$ ,  
AT COOLEY HIGH SCHOOL

Site	IITRI No.	Filter No.	Date	Day	TSP ( $\mu\text{g}/\text{m}^3$ )	Industrial Sources	Traffic, Soil	(Ammonium) Sulfates, Nitrates	Stationary Combustion Sources	Biological Aerosols
Cooley	80-412	9284476	01-30-79	TUES	94	33	11	45	9	<1
	413	4478	02-05-79	MON	98	21	29	26	22	<1
	414	4750	03-13-79	TUES	155	3	118	26	8	<2
	415	4998	04-06-79	FRI	93	5	73	12	3	<1
	416	5215	04-27-79	FRI	48	<1	34	11	4	<1
	417	5218	05-06-79	SUN	184	<2	160	20	2	<2
	418	9173794	06-26079	TUES	167	3	135	18	8	2
	419	3799	07-11-79	WED	48	<1	33	14	1	<1
	420	4529	09-06-79	THURS	30	<1	23	4	1	2
	421	4530	09-12-79	WED	196	<2	157	31	8	<2
	422	4763	11-05-79	MON	96	<1	73	16	5	2

Table 2

SOURCE CONTRIBUTIONS TO TSP CONCENTRATIONS,  $\mu\text{g}/\text{m}^3$ ,  
AT WASHINGTON HIGH SCHOOL

Site	IITRI No.	Filter No.	Date	Day	TSP ( $\mu\text{g}/\text{m}^3$ )	Industrial Sources	Traffic, Soil	(Ammonium) Sulfates, Nitrates	Stationary Combustion Sources	Biological Aerosols
Washington	80-397	9284627	02-11-79	SUN	97	33	11	45	9	<1
	398	9284632	01-03-79	WED	101	68	8	22	3	<1
	399	4901	03-01-79	THURS	58	30	6	21	<1	<1
	400	4908	03-10-79	SAT	325	182	104	26	13	<3
	401	9285139	03-27-79	FRI	55	18	18	14	4	1
	402	9174152	06-20-79	WED	102	47	26	22	1	1
	403	4453	07-17-79	TUES	48	20	18	8	1	<1
	404	4454	07-20-79	FRI	215	109	69	28	9	<2
	405	4455	07-20-79	FRI	250	136	75	30	8	<3
	406	4682	08-07-79	TUES	262	162	58	31	5	5
	407	4683	08-07-79	TUES	247	138	57	35	7	10
	408	4996	09-06-79	THURS	294	173	68	44	6	<3
	409	4995	09-06-79	THURS	398	227	84	80	8	<4
	410	5005	09-27-79	THURS	282	178	42	59	3	<3
	411	5361	10-12-79	FRI	287	201	49	29	9	<3

Table 3  
SOURCE CONTRIBUTIONS TO TSP CONCENTRATIONS,  $\mu\text{g}/\text{m}^3$ ,  
AT ADDAMS ELEMENTARY SCHOOL

Site	IITRI No.	Filter No.	Date	Day	TSP ( $\mu\text{g}/\text{m}^3$ )	Industrial Sources	Traffic, Soil	(Ammonium) Sulfates, Nitrates	Stationary Combustion Sources	Biological Aerosols
Addams	80-423	9285162	03-10-79	SAT	230	160	41	25	2	<2
	424	5166	03-22-79	THURS	200	54	68	32	42	<2
	425	9173723	04-12-79	THURS	93	36	36	16	1	4
	426	3946	05-21-79	MON	56	15	29	7	<1	4
	427	4447	07-17-79	TUES	36	18	10	6	2	<1
	428	4675	08-13-79	MON	193	102	50	35	2	4
	429	4678	08-22-79	WED	109	29	23	50	1	7
	430	4984	09-12-79	WED	214	49	83	77	4	<2
	431	4989	09-27-79	THURS	220	117	35	57	4	7
	432	5349	10-30-79	TUES	205	55	92	37	14	6
	433	5571	11-05-79	MON	95	29	37	24	2	3

Table 4

SOURCE CONTRIBUTIONS TO TSP CONCENTRATIONS, WT.PCT.,  
AT COOLEY HIGH SCHOOL

Site	IITRI No.	Filter No.	Date	Day	TSP ( $\mu\text{g}/\text{m}^3$ )	Industrial Sources	Traffic, Soil	(Ammonium) Sulfates, Nitrates	Stationary Combustion Sources	Biological Aerosols
Cooley	80-412	9284476	01-30-79	TUES	94	21	10	40	28	1
	413	4478	02-05-79	MON	98	21	30	27	22	<1
	414	4750	03-13-79	TUES	155	2	76	17	5	<1
	415	4998	04-06-79	FRI	93	5	79	13	3	<1
	416	5215	04-27-79	FRI	48	<1	70	22	8	<1
	417	5218	05-06-79	SUN	184	<1	87	11	1	1
	418	9173794	06-26-79	TUES	167	2	81	11	5	1
	419	3799	07-11-79	WED	48	<1	68	29	3	<1
	420	4529	09-06-79	THURS	30	<1	77	13	3	7
	421	4530	09-12-79	WED	196	<1	80	16	4	<1
	422	4763	11-05-79	MON	96	<1	76	17	5	2

Table 5  
SOURCE CONTRIBUTIONS TO TSP CONCENTRATIONS, WT.PCT.,  
AT WASHINGTON HIGH SCHOOL

Site	IITRI No.	Filter No.	Date	Day	TSP ( $\mu\text{g}/\text{m}^3$ )	Industrial Sources	Traffic, Soil	(Ammonium) Sulfates, Nitrates	Stationary Combustion Sources	Biological Aerosols
Washington	80-397	9284627	02-11-79	SUN	97	34	11	46	9	<1
	398	9284632	01-03-79	WED	101	67	8	22	3	<1
	399	4901	03-01-79	THURS	58	51	11	37	1	<1
	400	4908	03-10-79	SAT	325	56	32	8	4	<1
	401	9285139	03-27-79	FRI	55	32	33	26	1	6
	402	9174152	06-20-79	WED	102	46	25	22	1	6
	403	4453	07-17-79	TUES	48	42	38	16	3	1
	404	4454	07-20-79	FRI	215	51	32	13	4	<1
	405	4455	07-20-79	FRI	250	55	30	12	3	<1
	406	4682	08-07-79	TUES	262	62	22	12	2	2
	407	4683	08-07-79	TUES	247	56	23	14	3	4
	408	4996	09-06-79	THURS	294	59	23	15	2	<1
	409	4995	09-06-79	THURS	398	57	21	20	2	<1
	410	5005	09-27-79	THURS	282	63	15	21	1	<1
	411	5361	10-12-79	FRI	287	70	17	10	3	<1

Table 6

SOURCE CONTRIBUTIONS TO TSP CONCENTRATIONS, WT.PCT.,  
AT ADDAMS ELEMENTARY SCHOOL

Site	IITRI No.	Filter No.	Date	Day	TSP ( $\mu\text{g}/\text{m}^3$ )	Industrial Sources	Traffic, Soil	(Ammonium) Sulfates, Nitrates	Stationary Combustion Sources	Biological Aerosols
Addams	80-423	9285162	03-10-79	SAT	230	70	18	11	1	<1
	424	5166	03-22-79	THURS	200	27	34	16	21	<1
	425	9173723	04-12-79	THURS	93	39	39	17	1	4
	426	3946	05-21-79	MON	56	27	51	13	1	8
	427	4447	07-17-79	TUES	36	49	27	17	6	1
	428	4675	08-13-79	MON	193	53	26	18	1	2
	429	4678	08-22-79	WED	109	27	21	46	1	6
	430	4984	09-12-79	WED	214	23	39	36	2	<1
	431	4989	09-27-79	THURS	220	53	16	26	2	3
	432	5349	10-30-79	TUES	205	27	45	18	7	3
	433	5571	11-05-79	MON	95	31	39	25	2	3

Table 7

RESULTS OF ION CHROMATOGRAPHY ANALYSIS  
FOR WATER SOLUBLE SULFATE AND NITRATE CONCENTRATION, WT.PCT.

Site	IITRI No.	Filter No.	Sampling		TSP ( $\mu\text{g}/\text{m}^3$ )	% $\text{NO}_3^-$	% $\text{NH}_4\text{NO}_3$	% $\text{SO}_4^{--}$	% $(\text{NH}_4)_2\text{SO}_4$
			Date	Day of Week					
Cooley	80-412	9284476	01-30-79	TUES	94	16.2	20.9	14.0	19.3
	413	4478	02-05-79	MON	98	5.6	7.2	14.5	19.9
	414	4750	03-13-79	TUES	155	4.8	6.2	7.8	10.7
	415	4998	04-06-79	FRI	93	1.6	2.1	7.7	10.6
	416	5215	04-27-79	FRI	48	1.1	1.4	14.7	20.2
	417	5218	05-06-79	SUN	184	1.9	2.5	6.4	8.8
	418	9173794	06-26-79	TUES	167	2.9	3.7	4.1	5.6
	419	3799	07-11-79	WED	48	4.3	5.5	16.8	23.1
	420	4529	09-06-79	THURS	30	0.6	0.8	8.8	12.1
	421	4530	09-12-79	WED	196	4.9	6.3	7.1	9.8
	422	4763	11-05-79	MON	96	5.1	6.6	7.8	10.7
	80-397	9284627	02-11-79	SUN	97	12.6	16.3	21.6	29.7
Washington	398	4632	01-03-79	WED	101	4.3	5.5	11.9	16.4
	399	4904	03-01-79	THURS	58	5.4	7.0	21.5	29.6
	400	4908	03-10-79	SAT	325	0.6	0.8	5.0	6.9
	401	9285139	04-27-79	FRI	55	1.4	1.8	17.8	24.5

(continued)

Table 7 (Continued)

Site	IITRI No.	Filter No.	Sampling		TSP ( $\mu\text{g}/\text{m}^3$ )	% $\text{NO}_3^-$	% $\text{NH}_4\text{NO}_3$	% $\text{SO}_4^{=}$	% $(\text{NH}_4)_2\text{SO}_4$
			Date	Day of Week					
Washington (continued)	80-402	9174152	06-20-79	WED	102	3.7	4.8	12.3	16.9
	403	4453	07-17-79	TUES	48	1.4	1.8	10.3	14.2
	404	4454	07-20-79	FRI	215	3.2	4.1	6.2	8.5
	405	4455	07-20-79	FRI	250	3.2	4.1	5.6	7.7
	406	4682	08-07-79	TUES	262	1.6	2.1	7.3	10.0
	407	4683	08-07-79	TUES	247	1.6	2.1	8.4	11.6
	408	4996	09-06-79	THURS	294	2.3	3.0	8.8	12.1
	409	4995	09-06-79	THURS	398	2.9	3.7	12.1	16.6
	410	5005	09-27-79	THURS	282	4.0	5.1	11.5	15.8
	411	5361	10-12-79	FRI	287	0.9	1.2	6.2	8.5
	80-423	9285162	03-10-79	SAT	230	1.0	1.3	6.9	9.3
Addams	424	5166	03-22-79	THURS	200	2.0	2.6	9.8	13.4
	425	9173723	04-12-79	THURS	93	2.6	3.4	10.0	13.8
	426	3946	05-21-79	MON	56	1.0	1.3	8.3	11.4
	427	4447	07-17-79	TUES	36	1.3	1.7	10.8	14.9
	428	4675	08-13-79	MON	193	2.5	3.2	11.0	15.1
	429	4678	08-22-79	WED	109	5.9	7.6	27.9	38.4

(continued)

Table 7 (Continued)

Site	IITRI No.	Filter No.	Sampling		TSP ( $\mu\text{g}/\text{m}^3$ )	% $\text{NO}_3^-$	% $\text{NH}_4\text{NO}_3$	% $\text{SO}_4^{--}$	% $(\text{NH}_4)_2\text{SO}_4$
			Date	Day of Week					
Addams (continued)	80-430	9174984	09-12-79	WED	214	5.4	7.0	20.7	28.5
	431	4989	09-27-79	THURS	220	4.3	5.5	14.8	20.4
	432	5349	10-30-79	TUES	205	3.8	4.9	9.2	12.7
	433	5571	11-05-79	MON	95	6.9	8.9	11.8	16.2

Table 8

## METEOROLOGICAL DATA FROM CHICAGO'S MIDWAY AIRPORT CORRESPONDING TO HI-VOL SAMPLING DAYS

Date	Wind				% CALM	24 Hr. PPT, <sup>2</sup> in.		Snow Depth, in.	Notes
	Direction, deg.		Avg. Speed, mph	% PERS <sup>1</sup>		% CALM	Rain		
	Range	Avg.							
01-03-79	200-250	230	14	75	0	0	0	10	gusty gusty  gusty gusty
01-30-79	230-210	255	7	38	4	0.03	0.7	27	
02-05-79	170-290	240	9	25	0	0	0	23	
02-11-79	80-140	115	9	58	0	0.14	1.8	19	
03-01-79	270-110	360	6	25	8	0.08	tr	10	
03-10-79	240-280	265	12	83	0	tr	tr	tr	
03-13-79	180-270	215	16	8 <sup>*</sup>	0	tr	0	tr	
03-22-79	40-170	80	10	38	0	tr	0	0	
04-06-79	270-310	290	16	86	13 <sup>†</sup>	0	0	0	
04-12-79	150-270	180	18	67	0	tr	0	0	
04-27-79	360-190	60	8	46	13	0.04	0	0	
05-06-79	150-210	185	15	88	0	0	0	0	
05-21-79	340- 60	25	13	63	0	0	0	0	
06-20-79	160-200	175	17	96	0	0	0	0	
06-26-79	150-240	200	9	50	0	0	0	0	
07-11-79	150-220	190	9	46	4	0	0	0	
07-17-79	310- 50	15	12	75	0	tr	0	0	
07-20-79	variable (360)	6	6	8	8	0	0	0	
					(continued)				

\* Persistent 190° until 1600--94% (16 hrs), also gusty <sup>1</sup> PERS = PersistencePersistent 270° after 1600--88% (8 hrs) <sup>2</sup> PPT = Precipitation<sup>†</sup> All after 2150

Table 8 (continued)

Date	Wind				% CALM	24 hr. PPT, <sup>2</sup> in.		Snow Depth, in.	Notes
	Direction, deg.		Avg. Speed, mph	% PERS <sup>1</sup>		Rain	Snow		
	Range	Avg.							
08-07-79	180-270	235	11	46	0	0	0	0	
08-13-79	190-290	225	9	46	0	0.03	0	0	
08-22-79	120-210	165	10	50	0	**	**	**	
09-06-79	230-330	285	10	42	0	0	0	0	
09-12-79	170-210	185	9	96	0	0	0	0	
09-27-70	150-220	185	9	79	0	0	0	0	
10-12-79	200-310	275	13	63	0	0.02	0	0	
10-30-79	80-140	120	14	83	0	0	0	0	
11-05-79	140-200	170	10	67	0	tr	0	0	

\*\* Information not provided.

<sup>1</sup> PERS = Persistence<sup>2</sup> PPT = Precipitation

PROJECT C8564 SAMPLE NO. 80-411  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  287  
 REPORT DATE 2/27/81 SAMPLE DATE 10-12-79, SAT  
 SITE Washington

       % COMBUSTIBLE 6.2 %  $\text{SO}_4^{=}$  0.9 %  $\text{NO}_3^{-}$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	2	15	<1-35
carbonates	10	3	<1-79
clay, humus	4	9	<1-82
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<u>COMBUSTION SOURCES</u>			
glassy flyash	<0.5		<1-45
coal fragments	2	6	<1-85
partially combusted coal	1	2	
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	10	NA	NA
oil soot	-		
<u>BIOLOGICALS</u>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	10	2	<1-38
magnetic fragments	47	4	<1-86
titanium dioxide	-		
coke	10	10	<1-120
graphite	<0.5		<1-113
magnetic spheres	3	6	<1-20
slag	-		

Fig. 4 SAMPLE DATA SHEET

Among the other mineral components, quartz and feldspars are commonly found in hi-vol samples. These constituents are principally found in soils, along with clays and humus. (Humus is grouped with minerals because humus has a soil origin.) While quartz and feldspars are used in aggregate mixes, mainly as sand, they are more abundantly found and generated as aerosols by vehicles traveling over unpaved soil roadways. Wind entrainment is commonly blamed as the source of the soil aerosols (quartz, feldspars, and clays), but is rarely a significant source for the following reasons:

1. Most of the soil minerals found on hi-vols are in the geometric size range of  $<1\ \mu\text{m}$  to  $80\ \mu\text{m}$  and:
  - a) these size ranges are usually washed below or settled below the larger, surface soil grains and therefore are not available for wind entrainment on undisturbed surfaces,
  - b) are probably too large to be wind entrained below speeds of 25 knots. (IITRI studies of aerosol samples collected in a dry, arid region in Utah demonstrated that strong, gusty winds mainly produced mineral sizes below  $10\ \mu\text{m}$ .)
2. Many, if not all, of the high soil mineral content hi-vol samples occur on days when wind speeds are below 12 mph. Conversely, high wind speed days generally produce low mineral concentrations consisting of small particle sizes, in the absence of sources for mechanical entrainment.

The principal source of soil aerosols is presumed to be vehicle entrainment in the absence of construction or agricultural activities. The larger soil minerals ( $>30\ \mu\text{m}$ ) in urban areas certainly arrive from local sources, often dirt roads within industrial sites adjacent to the sampling site.

The remaining mineral components, "Other" and "Pavement", refer to minor soil accessory minerals and to the pavement binder, asphalt or cement, respectively. The smaller minerals could be transported from greater distances but it is reasonable to presume that much of the sub- $30\ \mu\text{m}$  minerals also derive from the same source(s) as the larger particles.

The components in the "Mobile Sources" category are self-explanatory, as are most of the components in "Combustion Sources". However, one component in

this latter category requires a brief explanation. The fine carbonaceous particles are discrete, submicrometer, opaque, black carbon particles. Their origin can be crushed oil soot, coal or coke that cannot be readily distinguished because their morphological features are indistinct in submicrometer sizes. However, these particles can be distinguished from the agglomerate chains produced from gasoline or diesel fuel combustion.

The "Miscellaneous" components contain a number of particle types that are explained below. The "non-magnetic iron oxides" comprise both hydrated iron oxides such as goethite and the anhydrous hematite. Both are found as weathering products in soils and also as corrosion products. Hematite is also found as spheroidal particles indicating prior molten state from industrial processing.

Magnetic fragments occur as irregular particles of magnetite ( $\text{Fe}_3\text{O}_4$ ) or wustite ( $\text{FeO}$ ), which are not distinguished microscopically. Magnetic slivers of bright, lustrous particles are categorized as metallic and presumed to be mechanical erosion products, possibly from mechanical wear of autos and trucks. The magnetic spheres are magnetite or wustite particles that were molten at some time. They are commonly encountered in steel making foundries, or in flyash emissions. The spheres are a minor component of flyash which must be present if spheroidal magnetite is assigned to pulverized coal combustion sources.

Graphite was in the form of bright, lustrous flakes with a complete or partial hexagonal shape. This morphology is typical of kish from cast iron production. Titanium dioxide was present as irregular, agglomerates of submicrometer pigment encapsulated in an organic matrix. These white agglomerates appeared to be similar to erosion products from painted lane markers on roadways.

Table 9 shows the component groupings used to summarize source impacts. The reasons for these component assignments are based on particle composition, meteorology data and microinventory reports.<sup>1</sup> These assignments are discussed in the next section.

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<sup>1</sup> A series of reports on TSP microinventories were prepared for the U.S. EPA Region V by ETA Engineering, Inc., Westmont, Illinois. Reports for Cooley High School, Washington High School and Addams Elementary School, prepared by D.P. Kuhanech, J.A. Dewey, J.A. Schramuk and D.O. Getty, were liberally used to compare analytical results with the inventories. In addition, a number of figures and tables were excerpted, as noted, for inclusion in this report.

Table 9

LIST OF COMPONENTS ASSIGNED TO EACH SUMMARY  
SOURCE CLASS PRESENTED IN TABLES 1-6

Industrial Sources	Traffic, Soil	Ammonium Sulfates, Nitrates	Stationary Combustion Aerosols	Biologicals
non-magnetic iron oxides	tailpipe exhaust	ammonium sulfate*	glassy flyash	pollen, spores, conidia
magnetic fragments	rubber tire fragments	ammonium nitrate*	coal fragments	plant parts
magnetic spheres	all minerals		partially combusted coal	insect fragments
coke	titanium dioxide		oil soot	plant tissue
graphite				starch
slag				
fine carbonaceous particles				

\* Taken from water soluble sulfate and water soluble nitrate concentrations determined by ion chromatography.

## 4. DISCUSSION OF RESULTS

### 4.1 COOLEY HIGH SCHOOL SITE (SAROAD NO. 14-1220-012)

Traffic and soil-related aerosols were by far the most significant contributors to TSP levels, comprising between 68% and 87% of the TSP level on all but two sampling days. On these two days, January 30 and February 5, when low concentrations of these aerosols (10% and 30%) were found, there was a snow cover of more than 20 inches on the ground, preventing suspension of particles by traffic.

In most samples, the predominant aerosol of the soil and traffic-related category was carbonate minerals. Carbonate levels up to about  $88 \mu\text{g}/\text{m}^3$  were found. Carbonates were usually present in TSP samples due to traffic degradation of pavement and suspension of dusts from unpaved, gravel-covered lots and roadways. There are seven gravel lots located within a kilometer of this site, one of which is south of the site and only 0.09 km away (Table 10 and Figure 5). The four days with the highest carbonate levels (and highest TSP levels) are March 13, May 6, June 26, and September 12, with carbonate levels of  $88 \mu\text{g}/\text{m}^3$ ,  $53 \mu\text{g}/\text{m}^3$ ,  $62 \mu\text{g}/\text{m}^3$ , and  $78 \mu\text{g}/\text{m}^3$ , respectively. The winds on all four days had southerly components, indicating that traffic on adjacent arterials and perhaps nearby gravel lots are likely sources for a large portion of the aerosols encountered at the Cooley sampling site (Table 10).

Soil minerals, primarily quartz and clay, were present at levels up to  $100 \mu\text{g}/\text{m}^3$  (May 6) in the samples analyzed. Considering that there are twenty-one areas within a kilometer of this site which are classified as "dirt lot", it is not surprising that soil minerals were major sample components.

Direct mobile emissions, rubber tire fragments and tailpipe exhaust, are also included in the Traffic-Soil category. Rubber tire fragments contributed up to about  $20 \mu\text{g}/\text{m}^3$  (September 12). Tailpipe exhaust comprised about 1% of most of the sample masses.

Ammonium sulfate and ammonium nitrate were fairly prominent components of TSP levels at this site. Levels were between  $4 \mu\text{g}/\text{m}^3$  and  $38 \mu\text{g}/\text{m}^3$ . These secondary aerosols are generally due to long range transport and not to local

*(text continued on page 33)*

Table 10

## SUMMARY AND LOCATIONS OF AREA SOURCES NEAR COOLEY HIGH SCHOOL\*

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
A2	YMCA Demolition 250' x 325'	1a	0.10	0	1.1	4639.70	446.57
A19	Dirt Lot 110' x 120'	1b	0.10	163	0.18	4639.50	446.60
A20	Dirt Lot 30' x 110'	1b	0.09	159	0.05	4639.52	446.60
A21	Gravel Lot 110' x 280'	1b	0.09	159	0.42	4639.52	446.60
A1	Dirt - Grounds Around Monitor 95,000 ft <sup>2</sup>	1d	0.00	45	0.34	4639.60	446.57
A3	Building Demolition 70' x 110'	2	0.10	17	0.11	4639.70	446.60
A4	Bare Dirt, Vacant Lot 110' x 80'	2	0.16	11	0.12	4639.76	446.60
A5	Dirt Parking Lot 110' x 40'	2	0.25	7	0.08	4639.85	446.60
A6	Dirt Parking Lot 110' x 40'	2	0.29	31	0.08	4639.85	446.72

\* Taken from Reference 1.

N.B. The source numbers listed in Table 10 correspond to the numbers shown in Figure 5.

(continued)

Table 10 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
A7	Dirt Lot 120' x 110' Two Dirt Piles, 10' Diameter x 7' High	2	0.27	42	0.19	4639.80	446.75
A8	Dirt Parking Lot	2	0.23	50	0.07	4639.75	446.75
A24	Dirt Construction Site 300' x 250'	5	0.36	303	1.0	4639.80	446.27
A25	Construction Site w/Dirt Area - 650' x 500' Piles - 30' x 50' x 12' High	5	0.27	270	4.7	4639.60	446.30
A23	Demolition Debris (Temp.) 250' x 300'	7	0.70	130	4.9	4639.15	447.10
A26	Dirt Lot 250' x 125'	8	0.51	227	0.42	4639.25	446.20
A27	Gravel and Dirt Truck Storage Lot 800' x 175'	8	0.55	230	1.9	4639.25	446.15
A30	Scrap Metal Yard - Dirt 600' x 250'	8	0.82	211	2.0	4638.90	446.15

(continued)  
N.B. The source numbers listed in Table 10 correspond to the numbers shown in Figure 5.

Table 10 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
A31	Gravel RR Beds 1200' x 500'	8	0.81	252	8.0	4639.35	445.80
A32	Gravel Substation Yard 1000' x 250'	8	0.72	194	3.4	4638.90	446.40
A29	Dirt Construction Site 650' x 20' x 7' High Mounds	9	0.69	296	1.8	4639.90	445.95
A9	Vacant Lot 110' x 70'	2	0.19	51	0.10	4639.72	446.72
A10	Gravel Parking Lot 60' x 110'	2	0.17	62	0.09	4639.68	446.72
A11	Dirt Lot 60' x 110'	2	0.20	66	0.09	4639.68	446.75
A16	Gravel Parking 60' x 110'	2	0.25	5	0.12	4639.85	446.59
A17	Dirt Lot 10' High Dirt Piles Extending Length of Block 700' x 40'	2	0.40	4	0.38	4640.00	446.60

(continued)

N.B. The source numbers listed in Table 10 correspond to the numbers shown in Figure 5.

Table 10 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
A18	Dirt Lot 110' x 210'	2	0.32	62	0.31	4639.75	446.85
A12	Dirt Lot 30' x 110'	3	0.15	98	0.05	4639.58	446.72
A13	Dirt Lot 30' x 110'	3	0.21	135	0.05	4639.45	446.72
A14	Dirt Lot with Parking 100' x 110'	3	0.42	155	0.29	4639.22	446.75
A15	Gravel - Sign Storage Lot with Debris 80' x 110'	3	0.39	157	0.11	4639.24	446.72
A28	Scrap Metal Yard - Dirt 100' x 100' x 10' High Piles of Scrap Metal	4	0.82	211	0.14	4638.90	446.15

N.B. The source numbers listed in Table 10 correspond to the numbers shown in Figure 5.

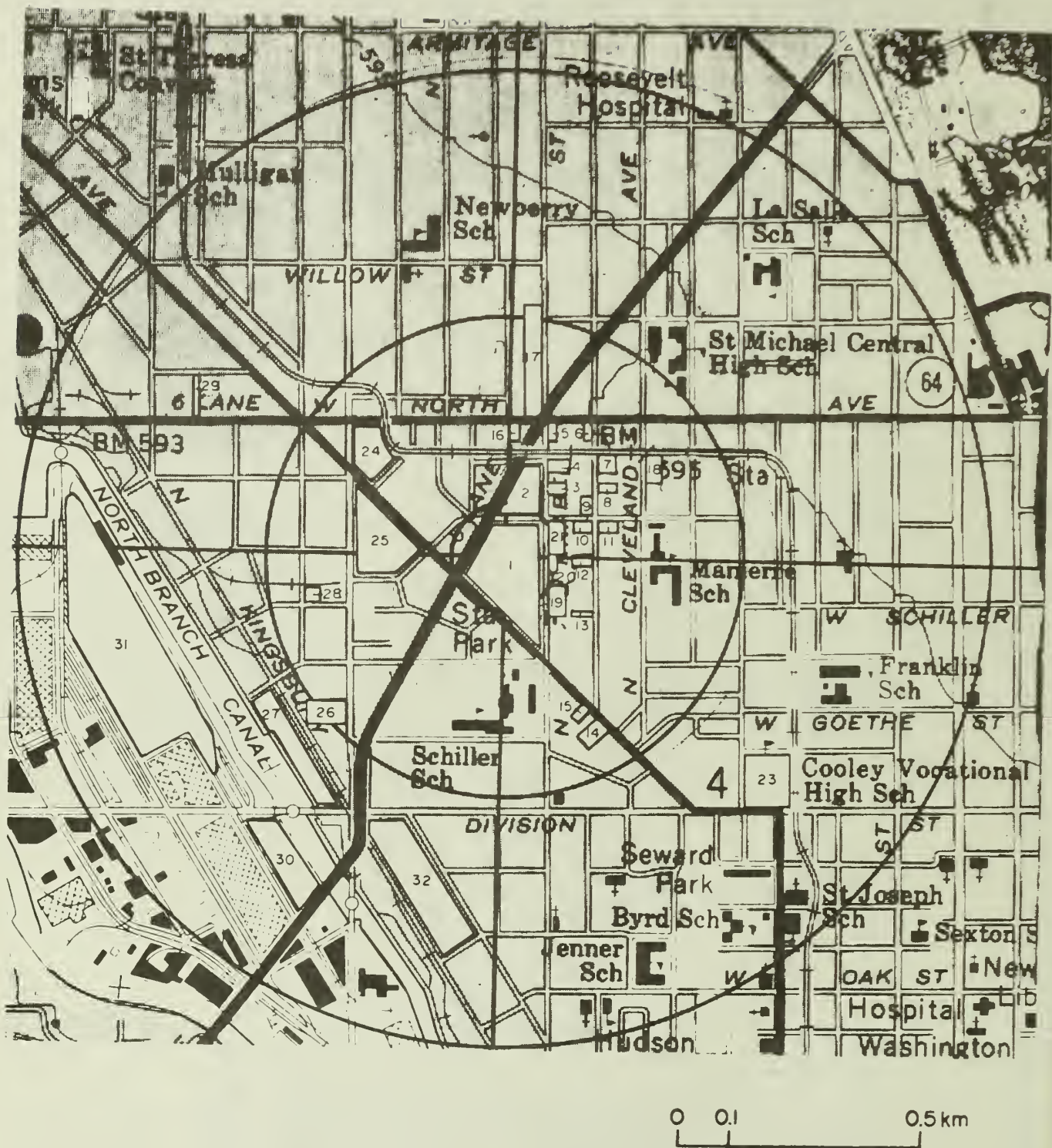


Fig. 5 MAP OF ONE KILOMETER RADIUS AROUND COOLEY HIGH SCHOOL SAMPLING SITE

\* Taken from Reference 1.

sources. Samples collected on the same date from different sites would be needed to confirm this supposition. The evidence presented in Table 11 supports the concept of long range transport in most cases with the exception of the samples collected on September 6 and 12, 1979.

Magnetic fragments were the only aerosol included in the "industrial" category which were present at a greater than trace level in samples collected at the Cooley site. The two dates when magnetic fragments made the greatest impact are January 30 and February 5, with impacts of  $26 \mu\text{g}/\text{m}^3$  and  $22 \mu\text{g}/\text{m}^3$ , respectively. Slightly elevated impacts of  $8 \mu\text{g}/\text{m}^3$  were made to the TSP levels on both May 6 and September 12. All four of these dates had their predominant wind directions in the southwest quadrant. Located 0.82 km from the sampling site at  $211^\circ$  is a scrap metal yard. On January 30 and February 5, when the levels of magnetic fragments in the samples were particularly high, it is likely that scrap metal was being moved or dumped. It is not likely that wind suspension is the mode of elevation since the particles are large and have high relative densities and because the thick layer of snow present on the two dates would suppress wind suspension from scrap piles.

Oil soot made the greatest impact to TSP levels on the winter sampling dates, January 30 and February 5, with levels of  $25 \mu\text{g}/\text{m}^3$  and  $20 \mu\text{g}/\text{m}^3$ , respectively. It is likely that the oil soot was due to heating units in the vicinity of the site since the oil soot level dropped dramatically as the weather became warmer.

Flyash was present at greater than trace levels ( $<0.8\%$ ) only when the wind was from the south-southwest. Located about 6 km away at  $188^\circ$  from the sampler is the Commonwealth Edison Fisk Station. The flyash encountered was fine, transparent and spherical--typical of that emitted from a pulverized coal-fired boiler.

Figure 6 is a graphical presentation of source impact versus average wind direction at Cooley High School. As this figure shows and from the data in Tables 12 and 13, it is apparent that point source emission impacts are negligible except for transported sulfates and nitrates.

*(text continued on page 41)*

Table 11

COMPARISON OF SULFATE AND NITRATE CONCENTRATIONS  
FOR DIFFERENT CHICAGO HI-VOL SITES ON THE SAME DAY

Date	Sulfate Concentrations, $\mu\text{g}/\text{m}^3$			Nitrate Concentrations, $\mu\text{g}/\text{m}^3$		
	Cooley	Addams	Washington	Cooley	Addams	Washington
04/27/79	7.1		9.8	0.5		0.8
07/17/79		3.9	4.9		0.5	0.7
09/06/79	2.6		48	0.2		12
09/12/79	14	44		9.6	12	
09/27/79		33	32			11
11/05/79	7.5	11		4.9	6.6	

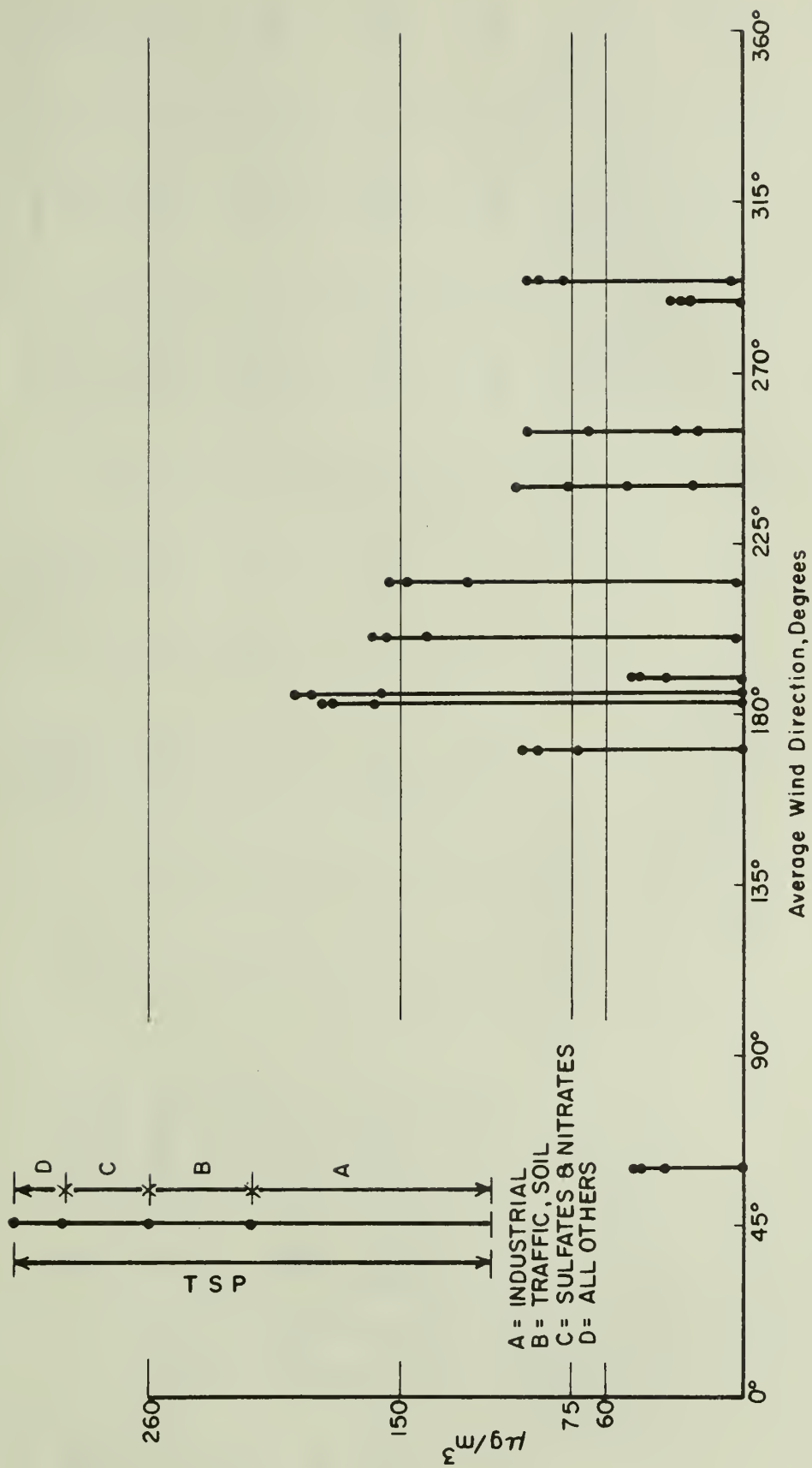


Fig. 6 SOURCE IMPACT BY WIND DIRECTION FOR COOLEY HIGH SCHOOL

Table 12  
SUMMARY OF SOURCE IMPACTS AND METEOROLOGICAL DATA  
FOR COOLEY HIGH SCHOOL

Date	Wind Speed, (mph)	Wind Direction		% Wind Persistence	% Calm	TSP	Industrial Sources ( $\mu\text{g}/\text{m}^3$ )	Traffic, Soil ( $\mu\text{g}/\text{m}^3$ )	Ammonium Sulfates, Nitrates ( $\mu\text{g}/\text{m}^3$ )	Stationary Combustion Sources ( $\mu\text{g}/\text{m}^3$ )	Biologicals ( $\mu\text{g}/\text{m}^3$ )
		Average (deg.)	Range (deg.)								
09/12/79	9	185	170-210	96	0	196	<2	157	31	8	<2
05/06/79	15	185	150-210	88	0	184	<2	160	20	2	2
06/26/79	9	200	150-240	50	0	167	3	135	18	8	2
03/13/79	16	215	180-270	8	0	155	3	118	26	8	<2
02/05/79	9	240	170-290	25	0	98	21	29	26	22	<1
11/05/79	10	170	140-200	67	0	96	<1	73	16	5	2
01/30/79	7	255	230-310	38	4	94	20	9	38	26	<1
04/06/79	16	290	270-310	86	13	93	5	73	12	3	<1
04/27/79	8	60	360-190	46	13	48	<1	34	11	4	<1
07/11/79	9	190	150-220	46	4	48	<1	33	14	1	<1
09/06/79	10	285	230-330	42	0	30	<1	23	4	1	2

Table 13

## SUMMARY AND LOCATION OF POINT SOURCES NEAR COOLEY HIGH SCHOOL \*

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P21	Standard Oil Building 200 E. Randolph Chicago	11	3.24	143	40.13	4637.0	448.5
P4	Lessner Corp. 1000 N. Branch St. Chicago	12	1.14	250	181.65	4639.2	445.5
P13	Dixie Portland Flour 1300 W. Carroll Chicago	12	2.68	211	116.90	4637.3	445.2
P14	Container Corp. 900 N. Ogden Chicago	12	2.68	211	38.80	4637.3	445.2
P5	Proctor and Gamble 1232 W. North Ave. Chicago	13	1.20	284	291.50	4639.9	445.4
P9	Sipi Metals Corp. 1720 N. Elston Chicago	13	1.74	287	55.09	4640.1	444.9
P12	A. Finkel and Sons 1405 W. Cortland Chicago	13	1.72	301	132.96	4640.5	445.1

\* Taken from Reference 1.

(continued)

Table 13 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P16	R. R. Donnelly 350 E. 22nd Chicago	15	6.46	163	26.10	4633.4	448.4
P1	Edward Hines Lumber Co. 2431 S. Wolcott Chicago	16	7.14	200	26.80	4632.9	444.1
P3	Harco Aluminum Co. 4528 W. Division Chicago	16	7.99	266	38.16	4639.0	438.6
P6	Commonwealth Edison Co. Fisk Station 1111 W. Cermak Chicago	16	6.35	188	478.32	4633.3	445.7
P8	Celotex Corp. 2800 S. Sacramento Chicago	16	8.89	212	30.06	4632.1	441.8
P10	Garvey Grain Inc. Santa Fe Elevator 2800 S. Winchester Chicago	16	7.77	200	32.62	4632.3	443.9

(continued)

Table 13 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P11	Allied Metals 1050 S. Canal Chicago	16	6.76	196	26.22	4633.1	444.7
P15	Connelly - GPM 3154 S. California Chicago	16	9.16	208	181.39	4631.5	442.3
P17	E. J. Brach 4656 W. Kinzie Chicago	16	8.39	254	27.03	4637.3	438.5
P18	Pettibone Corp. 4700 W. Division Chicago	16	8.01	264	32.95	4638.8	438.6
P19	Northwest Incinerator 750 N. Kilbourne Chicago	16	8.05	258	249.80	4637.9	438.7
P20	University of Illinois Chicago Circle Medical Center 1717 W. Taylor Chicago	16	5.20	212	47.00	4635.2	443.8

(continued)

Table 13 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P22	Supplementary Fuel Processing Plant 34th and Hamlin Chicago	16	9.77	212	46.00	4631.3	441.4
P2	Continental Can Co. 1657 N. Kilpatrick Chicago	17	8.28	272	28.07	4640.0	438.3
P7	Central Soya Inc. 1825 N. Laramie Chicago	17	9.28	274	54.16	4640.2	437.3

4.2 WASHINGTON HIGH SCHOOL (SAROAD NO. 14-1220-022)  
AND ADDAMS ELEMENTARY SCHOOL (SAROAD NO. 14-1220-031)

Samples collected at the Washington and Addams sampling sites are being discussed together because the two sites are only 1.4 km apart. The Addams site is north-northeast of the Washington site at a compass direction of about 20°. Because of their proximity to one another, the sites were impacted by particles from the same sources.

At the Washington site (Figure 7), in all eleven samples submitted which have TSP levels that exceed 100  $\mu\text{g}/\text{m}^3$ , the primary contributors to these TSP levels were industrial sources (Figure 8 and Table 14). Three of the seven samples collected at the Addams site (Figure 9), which had loadings of  $>100 \mu\text{g}/\text{m}^3$ , were also most heavily impacted by industry (Figure 10 and Table 15). At both sites, the aerosols which contributed most of the remaining sample masses were roadway and soil minerals as well as secondary combustion aerosols, ammonium sulfate and ammonium nitrate. In all but one sample which was collected at the Addams site, particles emitted from stationary combustion sources made relatively small contributions to TSP levels at both sites, as did biological aerosols and direct mobile emissions.

Industrial aerosols contributed up to 227  $\mu\text{g}/\text{m}^3$  and 160  $\mu\text{g}/\text{m}^3$  to the TSP levels at the Washington and Addams sites, respectively (Tables 16 and 17). In all nine instances at the Washington site and half of the six instances at the Addams site when TSP standards were exceeded, industrial emissions were primarily responsible. Magnetic fragments and magnetic spheres from steel mills were the predominant industrial particulate types present. Also found were iron oxides, coke, graphite, and slag.

The spherical shape of some of the magnetic particles indicated that these aerosols were formed by the cooling of liquid metal droplets. A furnace for melting iron would be a likely source of these aerosols. Possible sources of magnetic fragment aerosols are disturbances of stockpiles or wastepiles, convection currents above a furnace carrying out feed materials, or finishing processes (i.e., at a foundry). Coke particles could be from coke ovens, coke stockpiles, or, as with the magnetic fragments, fugitive emissions from a furnace. Likely sources for iron oxides are iron waste and storage piles and iron melting furnaces. Graphite is a typical steel mill emission and slag

*(text continued on page 59)*

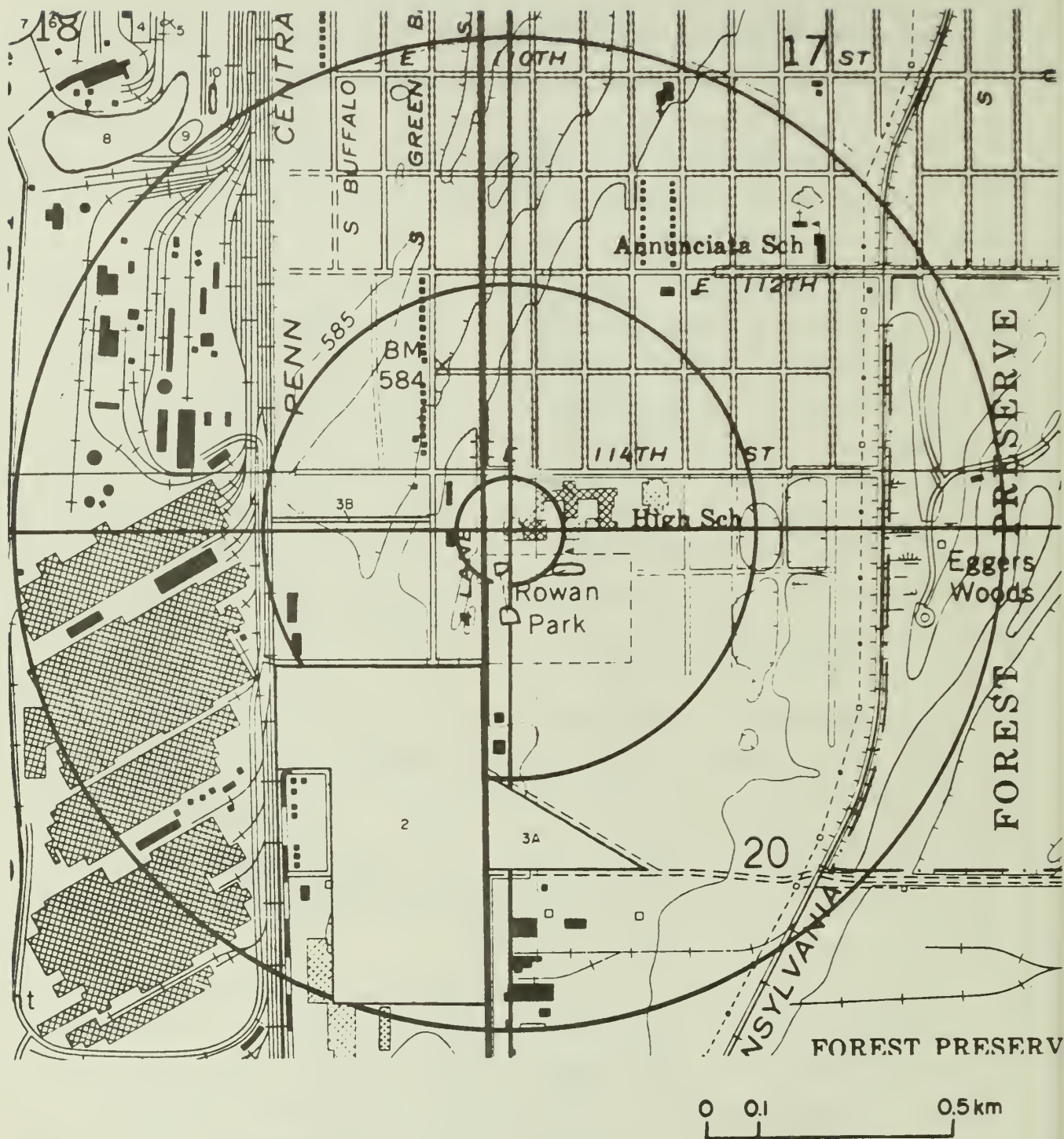


Fig. 7\* MAP OF ONE KILOMETER RADIUS AROUND WASHINGTON HIGH SCHOOL SAMPLING SITE

\* Taken from Reference 2.

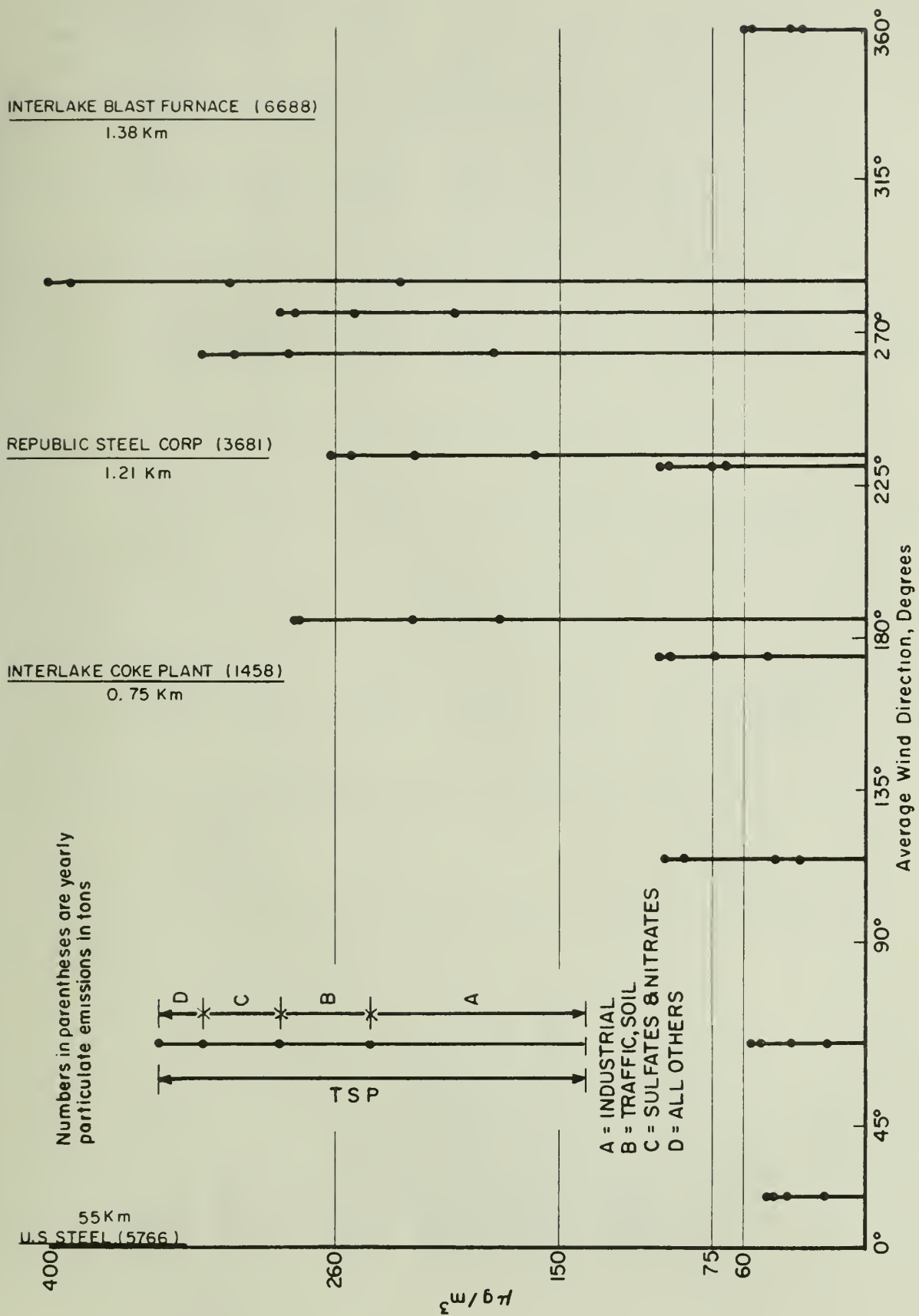


Fig. 8 SOURCE IMPACTS BY WIND DIRECTION FOR WASHINGTON HIGH SCHOOL

Table 14

## SUMMARY AND LOCATION OF POINT SOURCES NEAR WASHINGTON HIGH SCHOOL\*

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P26	Interlake Coke Plant 11236 S. Torrence Chicago	7	0.79	168	1457.54	4614.3	455.2
P24	Falstaff Brewing 103rd and Indianapolis Chicago	10	2.26	20	71.64	4617.2	455.8
P29	Material Service Corp. 9331 S. Ewing Chicago	10	4.22	1	46.50	4619.3	455.1
P32	Cinders Inc. 12009 Avenue O Chicago	11	2.40	161	111.69	4612.8	455.8
P16	Indiana Grain Corp. 12700 S. Butler Chicago	12	2.58	216	394.07	4613.0	453.5
P19	Republic Steel Corp. 11600 S. Burley Chicago	12	1.21	224	3681.08	4614.2	454.6
P20	Continental Grain Elevator B 11700 Torrence Chicago	12	1.76	248	213.93	4614.4	453.4

\* Taken from Reference 2.

(continued)

Table 14 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P21	Cargill 122nd and Torrence Chicago	12	2.34	221	719.27	4613.3	453.5
P22	Continental Grain Elevator C 127th and Calumet Chicago	12	2.48	221	323.87	4613.2	453.4
P33	Heckett Engineering 12315 S. Burley Chicago	12	1.90	190	175.76	4613.2	454.7
P34	Aglomet Chicago 12345 S. Carondolet Chicago	12	2.20	199	112.44	4613.0	454.3
P8	Campbell Soup Co. 2550 W. 105th Chicago	13	2.74	321	39.75	4617.2	453.3
P12	Illinois Slag and Ballast 2817 E. 99th Chicago	13	3.21	336	54.78	4618.0	453.7
P13	Marblehead Lime Co. 3245 E. 103rd Chicago	13	3.01	318	297.41	4617.3	453.0

(continued)

Table 14 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P15	Rail-to-Water Corporation E 101st and Calumet River Chicago	13	2.84	355	135.44	4617.9	454.8
P18	Interlake-Chicago Blast Furnace 10730 Burley Chicago	13	1.38	333	6688.30	4616.3	454.4
P23	Calumet Incinerator 10301 S. Stonely Chicago	13	4.29	300	58.40	4617.2	451.3
P25	General Mills 10459 Muskegon Chicago	13	2.37	329	207.80	4617.1	453.8
P27	Valley Mold and Iron 108th and Calumet River Chicago	13	1.54	352	115.38	4616.6	454.8
P17	U.S. Steel South Works 3426 E. 89th Chicago	14	5.53	2	5766.05	4620.6	455.2
P1	Cosden Oil and Chemical 142nd and Paxton Chicago	16	6.30	209	106.67	4609.6	452.0

(continued)

Table 14 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P2	Metro Containers 138th and Cottage Grove Dolton	16	7.00	226	105.85	4610.2	450.0
P3	Interlake Inc. 13500 Perry Ave. Riverdale	16	7.97	243	427.95	4611.5	447.9
P4	Heckett Engineering 135th and Perry Riverdale	16	7.44	245	99.37	4611.9	448.3
P5	International Minerals 130th and Indiana Riverdale	16	7.85	240	59.27	4611.2	448.2
P7	Sherwin-Williams 11541 S. Champlain Chicago	16	5.64	267	539.24	4614.8	449.4
P9	Chicago Castings Co. 1225 W. 120th Chicago	16	9.31	262	92.57	4613.8	445.8
P10	Ingersoll Products 1000 W. 120th Chicago	16	8.94	261	34.71	4613.7	446.2

(continued)

Table 14 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P14	Mississippi Lime 12200 S. Stoney Chicago	16	5.30	252	95.16	4613.4	450.0
P30	Chicago Paving and Construction 12701 S. Doty Chicago	16	5.48	257	116.73	4613.8	449.7
P6	GM - Electro Motive 900 E. 103rd Chicago	17	5.52	292	51.35	4617.1	449.9
P11	Chicago Water Dept. 351 W. 104th Chicago	17	7.87	284	201.60	4617.0	447.4
P28	Nashue Corp. 7800 Woodlawn Chicago	17	8.44	328	62.23	4622.2	450.5
P31	Ferroslog Box 17105 Chicago	17	5.04	356	534.96	4620.1	454.7

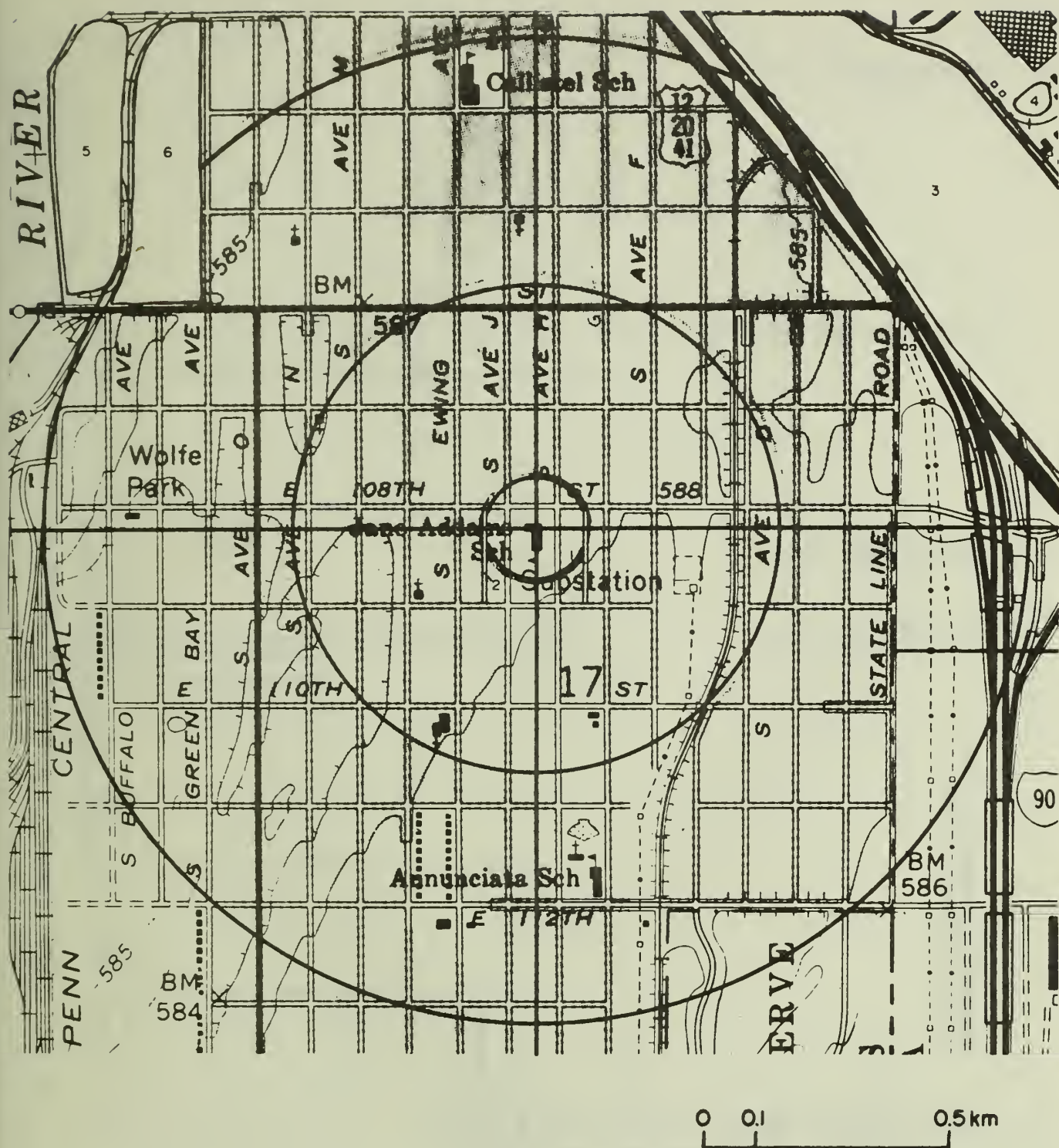


Fig. 9 MAP\* OF ONE KILOMETER RADIUS AROUND ADDAMS ELEMENTARY SCHOOL SAMPLING SITE

\* Taken from Reference 3.

U.S. STEEL WORKS (5766)  
4.5 Km

INTERLAKE BLAST FURNACE (6688)

REPUBLIC STEEL (3681)

INTERLAKE COKE (1458)

Numbers in parentheses are yearly  
particulate emissions in tons.

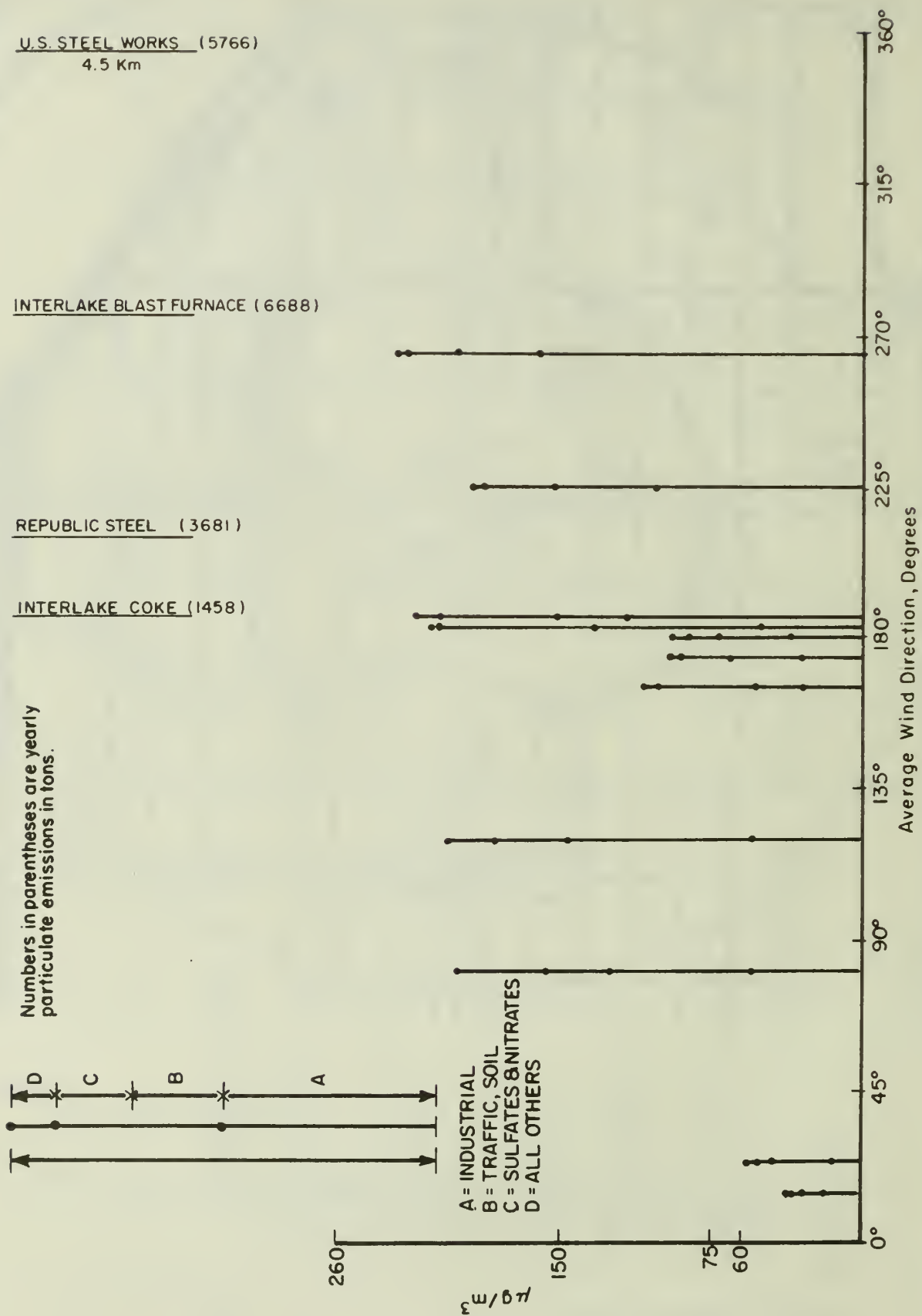


Fig. 10 SOURCE IMPACT BY WIND DIRECTION FOR ADDAMS ELEMENTARY SCHOOL

Table 15

## SUMMARY AND LOCATION OF POINT SOURCES NEAR ADDAMS ELEMENTARY SCHOOL\*

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P24	Falstaff Brewing 103rd and Indianapolis Chicago	10	1.03	2	71.64	4617.2	455.8
P32	Cinders, Inc. 12009 Avenue 0 Chicago	11	3.37	179	111.69	4612.8	455.8
P16	Indiana Grain Corp. 12700 S. Butler Chicago	12	3.90	216	394.07	4613.0	453.5
P19	Republic Steel Corp. 11600 S. Burley Chicago	12	2.29	211	3681.08	4614.2	454.6
P20	Continental Grain Elevator B 11700 Torrence Chicago	12	2.96	233	213.93	4614.4	453.4
P21	Cargill 122nd and Torrence Chicago	12	3.66	218	719.27	4613.3	453.5

\* Taken from Reference 3.

(continued)

Table 15 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P22	Continental Grain Elevator C 127th and Calumet Chicago	12	3.80	219	323.87	4613.2	453.4
P26	Interlake Coke Plant 11236 S. Torrence Chicago	12	1.96	187	1457.54	4614.3	455.2
P33	Heckett Engineering 12315 S. Burley Chicago	12	3.16	200	175.76	4613.2	454.7
P34	Aglomet Chicago 12345 S. Carondolet Chicago	12	3.49	205	112.44	4613.0	454.3
P8	Campbell Soup Co. 2550 W. 105th Chicago	13	2.67	293	39.75	4617.2	453.3
P12	Illinois Slag and Ballast 2817 E. 99th Chicago	13	2.76	312	54.78	4618.0	453.7

(continued)

Table 15 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P13	Marblehead Lime 3245 W. 103rd Chicago	13	2.98	292	297.41	4617.3	453.0
P15	Rail-to-Water Corp. E. 101st and Calumet River Chicago	13	1.98	331	135.44	4617.9	454.8
P17	U.S. Steel South Works 3426 E. 89th Chicago	13	4.46	353	5766.05	4620.6	455.2
P18	Interlake - Chicago Blast Furnace 10730 Burley Chicago	13	1.37	275	6688.30	4616.3	454.4
P23	Calumet Incinerator 10301 S. Stoney Chicago	13	4.58	283	58.40	4616.3	454.4
P25	General Mills 10459 Muskegon Chicago	13	2.17	295	207.80	4617.1	453.8

(continued)

Table 15 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P27	Valley Mold and Iron 108th and Calumet River Chicago	13	1.06	293	115.38	4616.6	454.8
P29	Material Service Corp. 9331 S. Ewing Chicago	13	3.20	348	46.50	4619.3	455.1
P31	Ferroslog Box 17105 Chicago	13	4.07	345	534.96	4620.1	454.7
P1	Cosden Oil and Chemical 142nd and Paxton - Calumet	16	7.57	240	106.67	4609.6	452.0
P2	Metro Containers 138th and Cottage Grove Dalton	16	8.30	224	105.85	4610.2	450.0
P3	Interlake Inc. 13500 Perry Avenue Riverdale	16	9.15	239	427.95	4611.5	447.9
P4	Heckett Engineering 135th and Perry Riverdale	16	8.60	240	99.37	4611.9	448.3

(continued)

Table 15 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P5	International Minerals 130th and Indiana Riverdale	16	9.05	237	59.27	4611.2	448.2
P7	Sherwin-Williams 11541 S. Champlain Chicago	16	6.51	258	539.24	4614.8	449.4
P10	Ingersoll Products 1000 W. 120th Chicago	16	9.88	256	34.71	4613.7	446.2
P14	Mississippi Lime Co. 12200 S. Stonely Chicago	16	6.40	244	95.16	4613.4	450.0
P30	Chicago Paving and Construction 12701 S. Doty Chicago	16	6.51	249	116.73	4613.8	449.7
P6	GM - Electro Motive 900 E. 103rd Chicago	17	5.94	279	51.35	4617.1	449.9

(continued)

Table 15 (Continued)

Source Number	Source Description	Sector Number	Distance from Monitor (km)	Direction from Monitor (deg)	TSP Emissions (T/y)	UTM Coordinates	
						North (km)	East (km)
P11	Chicago Water Dept. 351 W. 104th Chicago	17	8.40	276	201.60	4617.0	447.4
P28	Nashue Corp. 7800 Woodlawn Chicago	17	8.00	319	62.23	4622.2	450.5

Table 16

SUMMARY OF SOURCE IMPACTS AND METEOROLOGICAL DATA  
FOR WASHINGTON HIGH SCHOOL

Date	Wind Speed, (mph)	Wind Direction		% Wind Persistence	% Calm	TSP	Industrial Sources ( $\mu\text{g}/\text{m}^3$ )	Traffic, Soil ( $\mu\text{g}/\text{m}^3$ )	Ammonium Sulfates, Nitrates ( $\mu\text{g}/\text{m}^3$ )	Stationary Combustion Sources ( $\mu\text{g}/\text{m}^3$ )	Biologicals ( $\mu\text{g}/\text{m}^3$ )
		Average (deg.)	Range (deg.)								
09/06/79	10	285	230-330	42	0	398	227	84	80	8	<4
" *	"	"	"	"	"	294*	173	68	44	6	<3
03/10/79	12	265	240-280	83	0	325	182	104	26	13	<3
10/12/79	13	275	200-310	63	0	287	201	49	29	9	<3
09/27/79	9	185	150-220	79	0	282	178	42	59	3	<3
08/07/79	11	235	180-270	46	0	262	162	58	31	5	5
" *	"	"	"	"	"	247*	138	57	35	7	10
07/20/79	6	variables-----		0	8	250	136	75	30	8	<3
" *	"	"	"	"	"	215*	109	69	28	9	<2
06/20/79	17	175	160-200	96	0	102	47	26	22	1	6
01/03/79	14	230	200-250	75	0	101	68	8	22	3	<1
02/11/79	9	115	80-140	58	0	97	33	11	45	9	<1
03/01/79	6	360	270-110	25	8	58	30	6	21	<1	<1
04/27/79	8	60	360-190	46	13	55	18	18	14	4	1
07/17/79	12	15	310- 50	75	0	48	20	18	8	1	<1

\* Duplicate hi-vol sample.

Table 17

SUMMARY OF SOURCE IMPACTS AND METEOROLOGICAL DATA  
FOR ADDAMS ELEMENTARY SCHOOL

Date	Wind Speed, (mph)	Wind Direction		% Wind Persistence	% Calm	TSP	Industrial Sources ( $\mu\text{g}/\text{m}^3$ )	Traffic, Soil ( $\mu\text{g}/\text{m}^3$ )	Ammonium Sulfates, Nitrates ( $\mu\text{g}/\text{m}^3$ )	Stationary Combustion Sources ( $\mu\text{g}/\text{m}^3$ )	Biologicals ( $\mu\text{g}/\text{m}^3$ )
		Average (deg.)	Range (deg.)								
03/10/79	12	265	240-280	83	0	230	160	41	25	2	<2
09/27/79	9	185	150-220	79	0	220	117	35	57	4	7
09/12/79	9	185	170-210	96	0	214	49	83	77	4	<2
10/30/79	14	120	80-140	83	0	205	55	92	37	14	6
03/22/79	10	80	40-170	38	0	200	54	68	32	42	<2
08/13/79	9	225	190-290	46	0	193	102	50	35	2	4
08/22/79	10	165	120-210	50	0	109	29	23	50	1	7
11/05/79	10	170	140-200	67	0	95	29	37	24	2	3
04/12/79	18	180	150-270	67	0	93	36	36	16	1	4
05/21/79	13	25	340- 60	63	0	56	15	29	7	<1	4
07/17/79	12	15	310- 50	75	0	36	18	10	6	2	<1

emissions can be from a foundry, steel mill furnace or slag crushing plant. However, these are relatively minor emissions compared to the magnetic fragments and spheres.

Predominant winds from the southwest quadrant resulted in the greatest impact of all of the industrial particulate types encountered at the two sampling sites. The sources of most of these particles are thought to be fairly close to the sampling sites because of the high concentrations (up to  $100 \mu\text{g}/\text{m}^3$ ) and relatively large particle sizes. Graphite particles, though of low density and present only in trace levels, were generally  $>100 \mu\text{m}$  in diameter, also indicating a local source.

Iron oxide particles were generally very small (average diameter of  $1\text{-}2 \mu\text{m}$  in most samples) and few particles  $>10 \mu\text{m}$  were encountered. The relatively high concentrations indicates a near source in spite of these small particle sizes.

Point and area sources within 5 km and to the west or south of the sampling sites which may be responsible for the industrial aerosols found in the samples are listed in Table 18. Also listed are the types of particles they may emit and the location of each potential source with respect to each site. As can be seen from this table, there are several potential sources for each particle type. A comparison of the samples which were collected at the two sites on the same day provides a basis for selecting potential sources for the following days: March 10, July 17, and September 27, 1979. Figure 11 is a graphical comparison of the composition of these samples.

On March 10, 1979 there was a steady, westerly wind ( $240\text{-}280^\circ$  at the Midway meteorological station; persistence: 83%) and since the sites are separated on a north/south vector, some separation of sources to the west/southwest can be made. It should be restated that the actual wind directions may vary slightly from those reported at the Midway meteorological station. Figure 12 is a graphical comparison of the quantities ( $\mu\text{g}/\text{m}^3$ ) of each type of industrial aerosol encountered at each site. The compositions indicate that there are probably at least two sources of industrial aerosols upwind of the sites. One source is west and closer to Addams than to Washington and is emitting primarily magnetic fragments. Judging from the high level of magnetic fragments, it seems that a likely identity of this source is Interlake-Chicago Blast Furnace. This is also consistent with the types of magnetic fragments emitted from blast furnaces.

Table 18

POSSIBLE SOURCES OF INDUSTRIAL EMISSIONS ENCOUNTERED IN TSP SAMPLES  
AND THE TYPES OF AEROSOLS THEY MAY EMIT

Source	Possible Particulate Emissions	Distance from Washington (km)	Direction from Washington (deg)	Distance from Addams (km)	Direction from Addams (deg)
Interlake Coke Plant Republic Steel Corp.	coke, coal	0.79	168	1.96	187
	magnetic spheres, magnetic fragments, iron oxides, coke, graphite	1.21	224	2.29	211
Interlake-Chicago Blast Furnace	magnetic spheres, magnetic fragments, iron oxides	1.38	333	1.37	275
Valley Mold & Iron	magnetic spheres, magnetic fragments, iron oxides, coke	1.54	352	1.06	293
Iron Ore Piles	silicate minerals, magnetic fragments, iron oxides	1.05 1.31	312 315		
Coke Piles	coke	1.28	320		

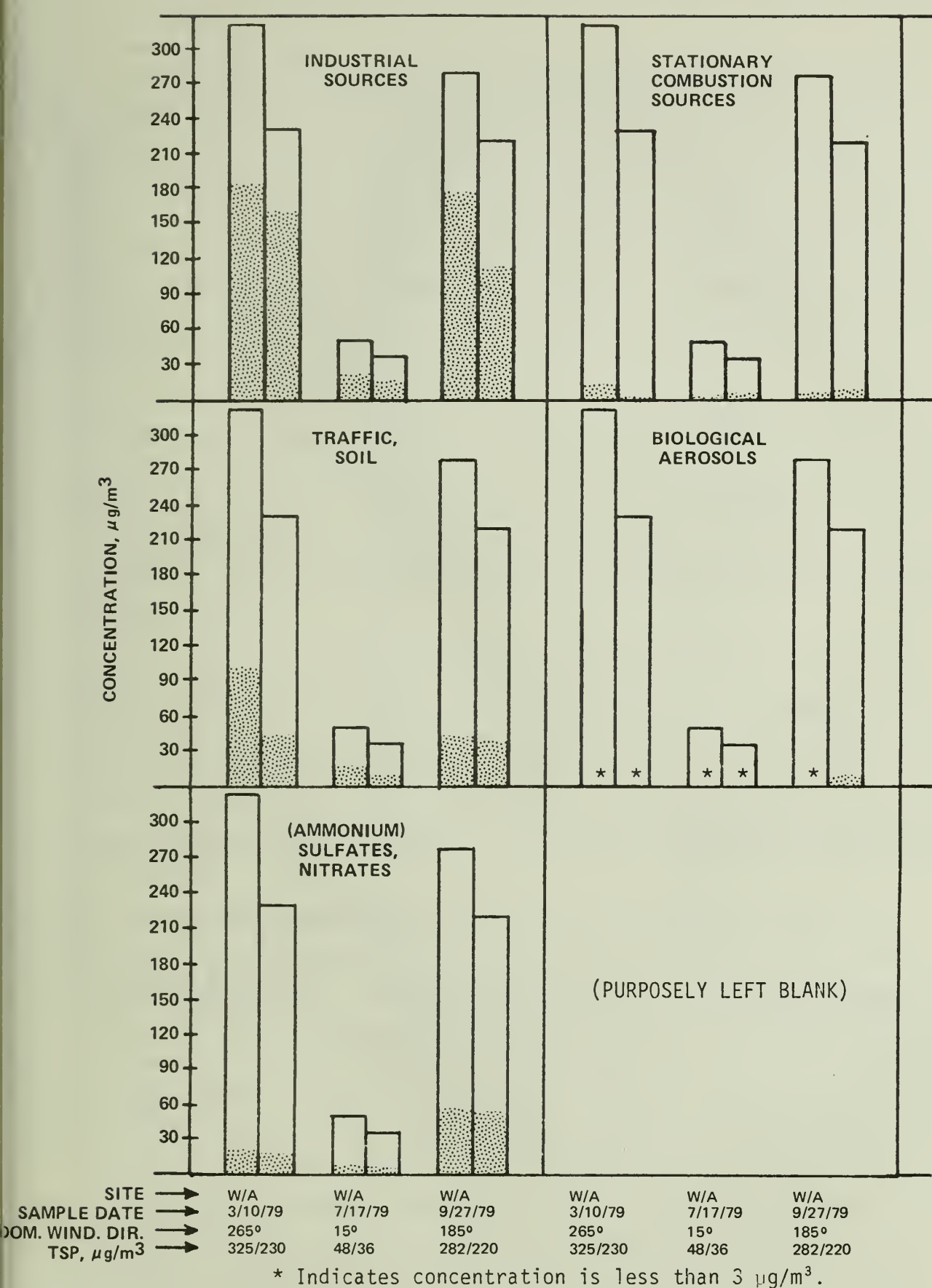
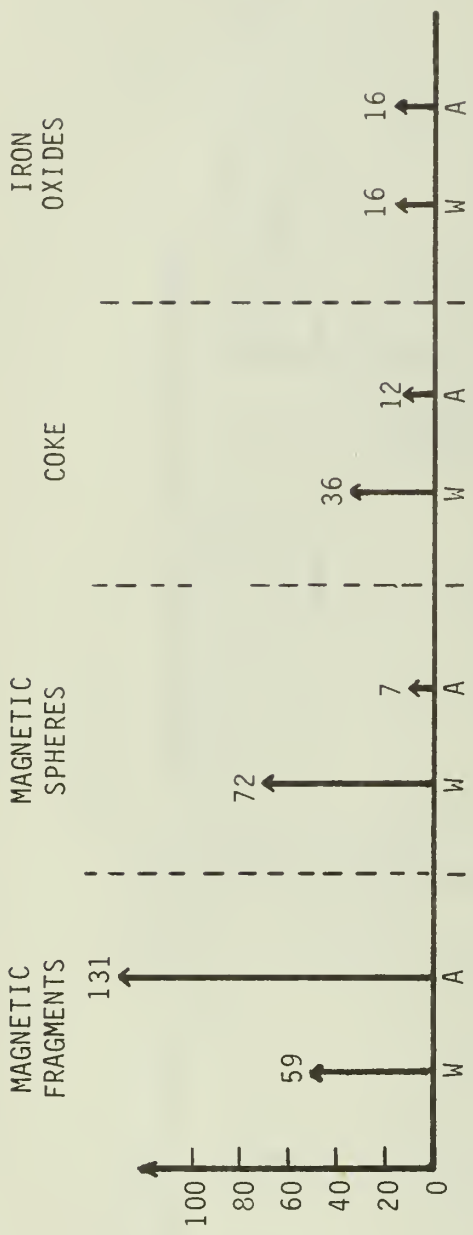


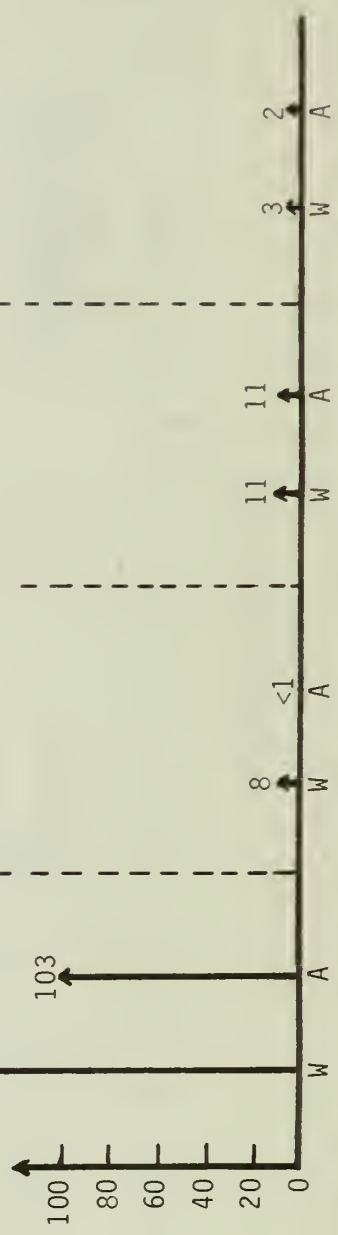
Fig. 11 COMPARISON OF SAMPLE COMPOSITION AT THE WASHINGTON (W) AND ADDAMS (A) SITES FOR THE SAME DAYS



March 10, 1979



July 17, 1979



September 27, 1979

The second source seems to be emitting magnetic spheres, magnetic fragments, coke, and lies closer to Washington than Addams. In fact, judging from the low level of magnetic spheres found in the Addams sample, the second source does not seem to be impacting the Addams site very heavily on this date. This second source may be Republic Steel Corporation. It is slightly south of the expected direction of the source of these aerosol but wind directions may vary from those at Midway. It is, however, the major source in that vicinity which emits the types of particulates found in the samples.

A coating of fine ( $\leq 1 \mu\text{m}$ ) iron oxide particles was found in both samples. The similarity in the appearances of these backgrounds indicates that the particles in both samples are from the same source or more likely, that both sources are emitting these particles. The sample collected on October 12, 1979 at Washington (80-411) was the only sample to contain a higher level of iron oxides at a level of  $29 \mu\text{g}/\text{m}^3$ . The wind on that day was also predominantly westerly at  $275^\circ$ .

The samples collected on July 17, 1979 have the lowest TSP of any sampling days at these sites. The wind on that day was northerly (predominant direction:  $15^\circ$ ) and industrial aerosols were present at levels  $\leq 20 \mu\text{g}/\text{m}^3$ --predominantly magnetic fragments in both cases. In fact, the three lowest levels of industrial aerosols encountered at the Washington site and the two lowest levels at Addams were all on days with predominantly northerly winds, as expected.

In contrast, the samples collected on September 27, 1979, when the predominant wind direction was  $185^\circ$ , had high TSP levels and high levels of industrial emissions:  $178 \mu\text{g}/\text{m}^3$  at Washington and  $117 \mu\text{g}/\text{m}^3$  at Addams. At both sites, close to 90% of the industrial aerosols were magnetic fragments. As known from the site inventory and from samples collected when northerly winds predominated, there are no industrial sources between the two sites. Therefore, with this wind direction, both sites are probably impacted by the same industrial source but the difference in the levels of magnetic fragments is due to the distance between the two sites. As on March 10, it is probable that this source is Republic Steel Corporation. The much lower concentrations of magnetic spheres on 27 September compared to 10 March suggests that the operations producing magnetic fragments and magnetic spheres are not the same.

It seems reasonable to assume that if Republic Steel Corporation and Interlake-Chicago Blast Furnace are the major sources of magnetic iron oxides found on the March 10 and September 27, 1979 samples, they also have contributed these aerosols to samples collected on days when the wind is from the west or south. When the wind was from the south and/or west, levels of magnetic fragments ranged from 23-155  $\mu\text{g}/\text{m}^3$  and magnetic spheres from 8-76  $\mu\text{g}/\text{m}^3$  at Washington. At Addams, magnetic fragments comprised 8-131  $\mu\text{g}/\text{m}^3$  and magnetic spheres up to 16  $\mu\text{g}/\text{m}^3$  of the TSP. It should be noted that magnetic particles were found at levels greater than 10  $\mu\text{g}/\text{m}^3$  in every sample analyzed, regardless of the wind direction. This suggests that the steel mill emissions had deposited on roadways near the sampling sites and were resuspended by traffic.

Of all of the samples analyzed, coke levels ranged up to 36  $\mu\text{g}/\text{m}^3$  and 31  $\mu\text{g}/\text{m}^3$  at the Washington and Addams sites, respectively. Elevated coke levels are accompanied by elevated levels of magnetic particles in all cases. The highest levels of coke were found in samples collected with a predominantly westerly wind, not a southerly wind as would be expected if the source were only the Interlake Coke Plant.

Soil and traffic-related aerosols were major contributors to TSP levels at both sites. Minerals accounted for most of the particles in this category. The minerals present were primarily limestone, quartz, and clay particles. The limestone was largely due to vehicular suspension of abraded pavement fragments and to traffic on unpaved gravel roadways and parking lots. However, some of the limestone may be due to raw materials handling in the steel complexes or as emissions from sintering.

At both sites, the soil levels and the limestone levels each ranged up to about 50  $\mu\text{g}/\text{m}^3$ . At Washington, the highest mineral levels were encountered when the wind had a strong westerly component.

Direct mobile emissions, tailpipe exhaust, and rubber tire fragments were relatively small contributors to TSP levels. Together they contributed less than 5  $\mu\text{g}/\text{m}^3$  to the samples collected at these two sites.

The average impact to TSP levels made by ammonium sulfates and nitrates was slightly over 30  $\mu\text{g}/\text{m}^3$  at each site. Concentrations ranged up to about 80  $\mu\text{g}/\text{m}^3$  at the Washington site and 77  $\mu\text{g}/\text{m}^3$  at the Addams site. These are secondary combustion aerosols and therefore probably not of local origin.

Fifteen percent ( $30 \mu\text{g}/\text{m}^3$ ) of the sample mass collected on March 22, 1979 at Addams (80-424) was comprised of glassy flyash from a pulverized coal combustion source. Since the predominant wind direction was about  $80^\circ$ , it is expected that the source is located to the east of the sampling site. The source may be more than 10 kilometers from the site since no such source is indicated in the site inventory. Most of the flyash was quite small ( $\leq 10 \mu\text{m}$ ) so impact from a source this distance from the site is possible.

All of the other samples analyzed which were collected at these sites had comparatively low levels ( $<15 \mu\text{g}/\text{m}^3$ ) of stationary combustion source emissions.

#### 4.2.1. Washington Site Dual Samples

Duplicate samples were submitted for analysis from the Washington site on 6 September, 7 August, and 20 July 1979. These samples were collected with two hi-vol sampling units operating simultaneously for 24-hour sampling periods. Table 19 shows the TSP concentrations and compositions for the sampled aerosols.

The samples collected on 7 August and 20 July 1979 agree reasonably well in TSP concentration and aerosol component concentrations, certainly within the precision of hi-vol sampling and analytical methods for these high TSP values. The 6 September samples show unexplainable differences in TSP concentrations and, correspondingly, differences in aerosol concentrations by group. In part, these differences could be due to preferential passive loading on the higher TSP sample for 6 September. Passive loading differences are principally attributable to particles larger than  $10 \mu\text{m}$  in diameter, reflected in the concentrations of industrial and traffic generated aerosols. However, the difference in ammonium sulfate and ammonium nitrate contents are not due to passive loading since these aerosols have an aerodynamic diameter of less than  $1 \mu\text{m}$  and therefore do not settle onto the filter when the hi-vol sampler is off. When concentration differences occur among submicrometer aerosols, the cause is usually due to flowrate differences between the samplers. In general, prior experience has shown that higher flowrates produce greater concentrations of submicrometer aerosols, though are usually accompanied by lower concentrations of super-micrometer particles. Since this trend was not demonstrated in the 6 September samples, the overall results should be considered anomalous.



## REFERENCES

1. David P. Kuhanek, James A. Dewey, Jeffrey A. Schramuk, and Darryl O. Getty, *Microinventory for Particulate Monitoring Site Located at Cooley High School*, ETA Engineering, Inc., Westmont, Illinois, prepared for U.S. EPA Region V (Contract No. 68-02-2888, Work Assignment No. 4) (no date).
2. David P. Kuhanek, James A. Dewey, Jeffrey A. Schramuk and Darryl O. Getty, *Microinventory for Particulate Monitoring Site Located at Washington High School*, ETA Engineering, Inc., Westmont, Illinois, prepared for U.S. EPA, Region V (Contract No. 68-02-2888, Work Assignment No. 4), (no date).

Appendix A  
METHODS OF ANALYSIS

## ANALYSIS METHODS

### SAMPLE SECTIONING

Each filter is examined microscopically to detect any abnormalities such as particle migration, water droplet staining, etc. A template specifically designed for hivol filter sample sectioning was then used to cut filter strips required for the various analyses. All filter sectioning with the template was performed on filters after they had been folded in half, sample side to sample side. A 2.5" x 1.5" (6.4 cm x 3.8 cm) section was cut for low temperature ashing (LTA). The filter section used for preparation of the PLM sample was cut from the 2.5" x 1.5" area facing the LTA section. The strip cut for the chemical analyses was 1" x 8" (2.5 cm x 20.3 cm).

### LOW TEMPERATURE ASHING (LTA)

The precisely measured sections of each filter cut for ashing were desiccated for 48 hours, weighed, then ashed for 2 hours in a low temperature oxygen plasma asher. Upon removal from this asher, the samples were cooled to room temperature in a desiccator and reweighed to determine mass lost in ashing. The percent mass loss in ashing is calculated from:

$$\% \text{ LTA loss} = \frac{\text{measured mass loss}}{\text{total mass of particles on the LTA section}}$$

where the total mass of particles on the LTA section (LTA section mass) is calculated from:

$$\text{LTA section mass} = \frac{\text{area of section ashed}}{\text{total hivol filter collection area}}$$

$$\times \text{mass of particles on total filter}$$

The percentage of combustibles determined by low temperatures ashing are shown in Table A of this appendix. Twenty two of the thirty seven samples had combustibles contents greater than 100%. This was due to an unusually high organic content in the blank glass fiber filters (probably used as a binder or strengthening agent). The organic binder content in these filters

Table A

COMBUSTIBLE CONCENTRATIONS DETERMINED  
BY LOW TEMPERATURE ASHING

Date	TSP	Combustibles %	Concentration $\mu\text{g}/\text{m}^3$
<u>Coolley High School</u>			
1 JAN	94	158	148
5 FEB	98	137	135
13 MAR	155	153	237
6 APR	93	99	92
27 APR	48	335	161
6 MAY	184	257	472
26 JUN	167	259	433
11 JUL	48	391	188
6 SEP	30	239	72
12 SEP	196	63	123
5 NOV	96	256	246
<u>Washington High School</u>			
3 JAN	101	167	169
11 FEB	97	124	120
1 MAR	58	143	83
10 MAR	325	130	423
27 APR	55	219	120
20 JUN	102	80	82
17 JUL	48	470	226
20 JUL	215	73	156
20 JUL	250	41	103
7 AUG	262	100	262
7 AUG	247	118	348
6 SEP	294	118	348
6 SEP	398	74	296
27 SEP	282	45	127
12 SEP	287	86	248
<u>Addams Elementary School</u>			
10 MAR	230	39	89
22 MAR	200	159	319
12 APR	93	304	283
21 MAY	56	315	177
17 JUL	36	191	69
13 AUG	193	65	125
22 AUG	109	97	106
12 SEP	214	161	345
27 SEP	220	50	110
30 OCT	205	63	128
5 NOV	95	98	93

was not consistent as determined by analyzing the combustible content of the filter margin which did not capture any aerosols. Because of this variability in the organic content of the filter, no blank could be subtracted and the LTA results were suspect and not used in this study.

## CHEMICAL ANALYSIS FOR SULFATE ( $\text{SO}_4^{=}$ ) AND NITRATE ( $\text{NO}_3^-$ )

The sections cut for sulfate and nitrate analysis were extracted in distilled, deionized water to dissolve the water soluble TSP components present. The extract was filtered through a 0.8  $\mu\text{m}$  membrane filter and diluted to 100 ml in a volumetric flask.

The anion concentrations in the extracts were determined by ion chromatographic analysis. The ion concentration determined was  $\mu\text{g}$  anion per ml of extract which, when multiplied by 100 ml, yielded the total mass of the anion on the entire 8 in.<sup>2</sup> (51.6 cm<sup>2</sup>) section. The mass percent concentration of each anion in the TSP was calculated in the same way that the percent LTA loss was calculated--i.e., after calculating the mass of particles present on the section analyzed from the total mass present on the entire filter.

## MICROSCOPICAL ANALYSES

### Sample Preparation

Triangular sections measuring approximately 2 cm on each side were cut from the ashed and unashed filters. The cut sections were mounted on individual glass slides in pools (approximately 0.5 ml) of standard immersion oil (refractive index = 1.515). After the mounting oil soaked through the filter section, a coverslip was placed on top to complete the mount. These slides for PLM analysis were prepared at least one week prior to the analysis to allow escape of most of the air bubbles entrapped in the filter matrix.

### Particle Identification

The samples were analyzed with a Zeiss optical microscope equipped for polarized light microscopy. Magnification ranging from 83X through 520X were routinely used in each sample analysis. Particle optical and physical properties were observed in each sample in order to identify the particle type. Magnetic properties of particles were observed by holding and moving a small horseshoe magnet near the microscope slide.

The ashed and unashed sections of each filter mounted for PLM analysis were systematically scanned. Measurements of the largest (linear dimension) particle for each identified particle type were recorded on an individual sample report form during this systematic scan.

Appendix B  
ANALYTICAL DATA SHEETS

PROJECT C8564 SAMPLE NO. 80-412  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  94  
 REPORT DATE 2/27/81 SAMPLE DATE 01-30-79, TUES  
 SITE Coolley

       % COMBUSTIBLE 14.0 %  $\text{SO}_4^{=}$  16.2 %  $\text{NO}_3^{-}$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	<0.5		<1-47
carbonates	2	4	<1-45
clay, humus	7	10	<1-68
other	<0.5		
pavement	<0.5		<1-72
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5		<1-59
coal fragments	<0.5		
partially combusted coal	1	1	<1-68
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	40	NA	NA
oil soot	27	2	<1-83
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	1		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	1	1	<1
magnetic fragments	20	7	<1-57
titanium dioxide	<0.5	1	<1-2
coke	-		
graphite	-		
magnetic spheres	-		
slag	-		

PROJECT C8564 SAMPLE NO. 80-413  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  98  
 REPORT DATE 2/27/81 SAMPLE DATE 02-15-79, MON  
 SITE Coolley

       % COMBUSTIBLE      14.5 %  $\text{SO}_4^{=}$       5.6 %  $\text{NO}_3^{-}$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	3	16	<1-68
carbonates	21	4	<1-79
clay, humus	3	9	<1-40
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	2	25	<1-86
<b>COMBUSTION SOURCES</b>			
glassy flyash	1	2	<1-26
coal fragments	<0-5		
partially combusted coal	1	1	
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	27	NA	NA
oil soot	20	3	
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	0.5	1	
magnetic fragments	20	8	<1-52
titanium dioxide	-		
coke	-		
graphite	-		
magnetic spheres	-		
slag	-		

PROJECT C8564SAMPLE NO. 80-414MICROSCOPIST KGSTSP,  $\mu\text{g}/\text{m}^3$  155REPORT DATE 2/27/81SAMPLE DATE 03-13-79, TUESSITE Cooley       % COMBUSTIBLE7.8 %  $\text{SO}_4^{=}$ 4.8 %  $\text{NO}_3^-$ 

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	9	18	<1-79
carbonates	57	5	<1-147
clay, humus	8	9	<1-94
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	1	30	<1-137
<u>COMBUSTION SOURCES</u>			
glassy flyash	0.5	2	<1-121
coal fragments	<0.5		
partially combusted coal	2	2	<1-117
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	17	NA	NA
oil soot	2	3	<1-80
<u>BIOLOGICALS</u>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	<0.5	1	<1-79
magnetic fragments	2	6	<1-26
titanium dioxide	-		
coke	-		
graphite	-		
magnetic spheres	-		
slag	-		

PROJECT C8564 SAMPLE NO. 80-415  
MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  93  
REPORT DATE 2/27/81 SAMPLE DATE 04-06-79, FRI  
SITE Cooley

       % COMBUSTIBLE 7.7 %  $\text{SO}_4^{=}$  1.6 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	28	16	<1-71
carbonates	35	5	<1-89
clay, humus	10	9	<1-110
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	5	25	<1-130
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5		
coal fragments	<0.5		
partially combusted coal	3	3	<1-185
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	13	NA	NA
oil soot	-	-	<1-49
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	0.5	2	<1-36
magnetic fragments	4	7	<1-35
titanium dioxide	<0.5	1	
coke	-		
graphite	-		
magnetic spheres	-		
slag	-		

PROJECT C8564 SAMPLE NO. 80-416  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  48  
 REPORT DATE 2/27/81 SAMPLE DATE 04-27-79, FRI  
 SITE Cooley

       % COMBUSTIBLE 14.7 %  $\text{SO}_4^{=}$  1.1 %  $\text{NO}_3^{-}$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	5	16	<1-83
carbonates	37	3	<1-60
clay, humus	8	9	<1-45
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	3	<1	<1
rubber tire fragments	17	25	<1-166
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	2	<1-17
coal fragments	<0.5		
partially combusted coal	2	2	<1-66
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	22	NA	NA
oil soot	6	3	<1-53
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	<0.5		
magnetic fragments	<0.5		
titanium dioxide	<0.5		
coke	-		
graphite	-		
magnetic spheres	-		
slag	<0.5		

PROJECT C8564 SAMPLE NO. 80-417  
MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  184  
REPORT DATE 2/27/81 SAMPLE DATE 05-06-79, SUN  
SITE Cooley

         % COMBUSTIBLE 6.4 %  $\text{SO}_4^{=}$  1.9 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	33	18	<1-114
carbonates	29	4	<1-59
clay, humus	21	12	<1-71
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	3	25	<1-147
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5		
coal fragments	<0.5		
partially combusted coal	1	3	<1-116
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	11	NA	NA
oil soot	<0.5		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	0.5		
plant parts	0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	<0.5		
magnetic fragments	<0.5		
titanium dioxide	-		
coke	-		
graphite	-		
magnetic spheres	-		
slag	-		

PROJECT C8564SAMPLE NO. 80-418MICROSCOPIST KGSTSP,  $\mu\text{g}/\text{m}^3$  167REPORT DATE 2/27/81SAMPLE DATE 06-26-79, TUESSITE Cooley       % COMBUSTIBLE4.1 %  $\text{SO}_4^{=}$ 2.9 %  $\text{NO}_3^-$ 

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	7	16	<1-55
carbonates	37	3	<1-86
clay, humus	32	12	<1-59
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	4	25	<1-143
<u>COMBUSTION SOURCES</u>			
glassy flyash	2	2	<1-28
coal fragments	<0.5		
partially combusted coal	3	3	<1-215
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	11	NA	NA
oil soot	<0.5		<1-45
<u>BIOLOGICALS</u>			
pollens, spores, conidia	0.5		
plant parts	0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	<0.5		
magnetic fragments	2	5	<1-57
titanium dioxide	<0.5		
coke	-		
graphite	-		
magnetic spheres	-		
slag	-		

PROJECT C8564 SAMPLE NO. 80-419  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  48  
 REPORT DATE 2/27/81 SAMPLE DATE 07-11-79, WED  
 SITE Cooley

       % COMBUSTIBLE 16.8 %  $\text{SO}_4^{=}$  4.3 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	3	16	<1-68
carbonates	20	6	<1-66
clay, humus	9	9	<1-110
other	<0.5		<1-109
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	35	30	<1-122
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5		
coal fragments	<0.5		
partially combusted coal	3	3	<1-111
fine carbonaceous particles	<0.5	1	1
ammonium sulfate and nitrate	29	NA	NA
oil soot	<0.5		<1-43
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	<0.5		
magnetic fragments	<0.5		
titanium dioxide	-		
coke	-		
graphite	-		
magnetic spheres	-		
slag	-		

PROJECT C8564 SAMPLE NO. 80-420  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  30  
 REPORT DATE 2/27/81 SAMPLE DATE 09-06-79, THURS  
 SITE Cooley

       % COMBUSTIBLE 8.8 %  $\text{SO}_4^{=}$  0.6 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	21	18	<1-68
carbonates	40	5	<1-62
clay, humus	5	9	<1-69
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	10	30	<1-260
<u>COMBUSTION SOURCES</u>			
glassy flyash	<0.5		
coal fragments	<0.5		
partially combusted coal	3	5	<1-185
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	13	NA	NA
oil soot	<0.5		
<u>BIOLOGICALS</u>			
pollens, spores, conidia	5		
plant parts	2		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	<0.5		
magnetic fragments	<0.5		
titanium dioxide	-		
coke	-		
graphite	-		
magnetic spheres	-		
slag	-		

PROJECT C8564 SAMPLE NO. 80-421  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  196  
 REPORT DATE 2/27/81 SAMPLE DATE 09-12-79, WED  
 SITE Cooley

       % COMBUSTIBLE 7.1 %  $\text{SO}_4^{=}$  4.9 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	14	18	<1-79
carbonates	40	5	<1-78
clay, humus	15	12	<1-71
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	10	30	<1-153
<b>COMBUSTION SOURCES</b>			
glassy flyash	0.5	2	<1-14
coal fragments	<0.5		
partially combusted coal	3	2	<1-122
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	16	NA	NA
oil soot	<0.5		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	<0.5		
magnetic fragments	<0.5		<1-61
titanium dioxide	-		
coke	-		
graphite	-		
magnetic spheres	-		
slag	-		

PROJECT C8564 SAMPLE NO. 80-422  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  96  
 REPORT DATE 2/27/81 SAMPLE DATE 11-05-79, MON  
 SITE Cooley

       % COMBUSTIBLE 7.8 %  $\text{SO}_4^{=}$  5.1 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	8	18	<1-56
carbonates	51	4	<1-81
clay, humus	10	9	<1-48
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	6	30	<1-147
<b>COMBUSTION SOURCES</b>			
glassy flyash	0.5	1	<1-27
coal fragments	<0.5		
partially combusted coal	4	4	<1-136
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	17	NA	NA
oil soot	<0.5		<1-50
<b>BIOLOGICALS</b>			
pollens, spores, conidia	1		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	1		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	<0.5		
magnetic fragments	<0.5		
titanium dioxide	<0.5		
coke	-		
graphite	-		
magnetic spheres	-		
slag	-		

PROJECT C8564 SAMPLE NO. 80-397  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  97  
 REPORT DATE 2/27/81 SAMPLE DATE 02-11-79, SUN  
 SITE Washington

       % COMBUSTIBLE 21.6 %  $\text{SO}_4^{=}$  12.6 %  $\text{NO}_3^{-}$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	5	12	<1-76
carbonates	3	4	<1-68
clay, humus	0.5		
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	2	<1	<1
rubber tire fragments	<0.5		
<u>COMBUSTION SOURCES</u>			
glassy flyash	3	2	<1-42
coal fragments	<0.5		<1-34
partially combusted coal	5	1	<1-79
fine carbonaceous particles	0.5	<1	<1
ammonium sulfate and nitrate	46	NA	NA
oil soot	<0.5	30	<1-59
<u>BIOLOGICALS</u>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	3	1	<1-21
magnetic fragments	13	3	<1-38
titanium dioxide	-		
coke	13	1	<1-198
graphite	<0.5		<1-136
magnetic spheres	5	11	<1-22
slag	<0.5		<1-79

PROJECT C8564 SAMPLE NO. 80-398  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  101  
 REPORT DATE 2/27/81 SAMPLE DATE 01-03-79, WED  
 SITE Washington

       % COMBUSTIBLE 11.9 %  $\text{SO}_4^{=}$  4.3 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	2	14	<1-75
carbonates	2	4	<1-66
clay, humus	2	10	<1-90
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	2	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	0.5	6	<1-43
coal fragments	<0.5		<1-68
partially combusted coal	2	2	<1-101
fine carbonaceous particles	0.5	<1	<1
ammonium sulfate and nitrate	22	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	6	1	<1-67
magnetic fragments	29	4	<1-39
titanium dioxide	-		
coke	2	20	<1-125
graphite	<0.5		
magnetic spheres	30	5	<1-21
slag	-		

PROJECT C8564 SAMPLE NO. 80-399  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  58  
 REPORT DATE 2/27/81 SAMPLE DATE 03-01-79, THURS  
 SITE Washington

       % COMBUSTIBLE 21.5 %  $\text{SO}_4^{=}$  5.4 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	0.5		<1-73
carbonates	8	6	<1-67
clay, humus	0.5		
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	1	35	<1-102
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	3	<1-43
coal fragments	<0.5		<1-68
partially combusted coal	1	1	<1-88
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	37	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	6	<1	<1-61
magnetic fragments	4	4	<1-50
titanium dioxide	-		
coke	<0.5		<1-103
graphite	<0.5		
magnetic spheres	41	9	<1-25
slag	-		

PROJECT C8564SAMPLE NO. 80-400MICROSCOPIST KGSTSP,  $\mu\text{g}/\text{m}^3$  325REPORT DATE 2/27/81SAMPLE DATE 03-10-79, SATSITE Washington       % COMBUSTIBLE5.0 %  $\text{SO}_4^{=}$ 0.6 %  $\text{NO}_3^-$ 

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	4	12	<1-71
carbonates	15	4	<1-45
clay, humus	12	10	<1-83
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5		
coal fragments	3	6	<1-79
partially combusted coal	1		
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	8	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	5	2	<1-49
magnetic fragments	18	6	<1-34
titanium dioxide	-		
coke	11	11	<1-216
graphite	<0.5		
magnetic spheres	22	9	<1-23
slag	-		

PROJECT C8564 SAMPLE NO. 80-401  
MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  55  
REPORT DATE 2/27/81 SAMPLE DATE 04-27-79, FRI  
SITE Washington

       % COMBUSTIBLE      17.8 %  $\text{SO}_4^{=}$       1.4 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	5	9	<1-63
carbonates	17	3	<1-62
clay, humus	2	9	<1-57
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	8	23	<1-112
<b>COMBUSTION SOURCES</b>			
glassy flyash	3	3	<1-26
coal fragments	2	10	<1-69
partially combusted coal	2	1	<1-68
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	26	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	1		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	1		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	5	1	<1-55
magnetic fragments	13	6	<1-67
titanium dioxide	-		
coke	7	12	<1-110
graphite	<0.5		
magnetic spheres	7	8	<1-24
slag	-		

PROJECT C8564SAMPLE NO. 80-402MICROSCOPIST KGSTSP,  $\mu\text{g}/\text{m}^3$  102REPORT DATE 2/27/81SAMPLE DATE 06-20-79, WEDSITE Washington       % COMBUSTIBLE12.3 %  $\text{SO}_4^{=}$ 3.7 %  $\text{NO}_3^-$ 

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	3	10	<1-68
carbonates	15	4	<1-57
clay, humus	2	12	<1-135
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	4	25	<1-203
<u>COMBUSTION SOURCES</u>			
glassy flyash	<0.5	4	<1-35
coal fragments	0.5		<1-70
partially combusted coal	0.5		
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	22	NA	NA
oil soot	-		
<u>BIOLOGICALS</u>			
pollens, spores, conidia	0.5		
plant parts	4		
insect fragments	<0.5		
plant tissue	<0.5		
starch	1		
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	10	2	<1-51
magnetic fragments	23	7	<1-63
titanium dioxide	-		
coke	1	5	<1-92
graphite	<0.5		
magnetic spheres	12	10	<1-39
slag	<0.5		

PROJECT C8564 SAMPLE NO. 80-403  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  48  
 REPORT DATE 2/27/81 SAMPLE DATE 07-17-79, TUES  
 SITE Washington

       % COMBUSTIBLE 10.3 %  $\text{SO}_4^{=}$  1.4 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	3	9	<1-57
carbonates	30	3	<1-93
clay, humus	2	9	<1-91
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	2	25	<1-115
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	2	<1-29
coal fragments	2	12	<1-114
partially combusted coal	1		<1-102
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	16	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	0.5		
plant parts	0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	5	2	<1-68
magnetic fragments	23	4	<1-53
titanium dioxide	-		
coke	2		<1-112
graphite	<0.5		
magnetic spheres	12	5	<1-36
slag	-		

PROJECT C8564 SAMPLE NO. 80-404  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  215  
 REPORT DATE 2/27/81 SAMPLE DATE 07-20-79, FRI  
 SITE Washington

       % COMBUSTIBLE 6.2 %  $\text{SO}_4^{=}$  3.2 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	1	12	<1-56
carbonates	22	5	<1-68
clay, humus	8	13	<1-78
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	7	<1-27
coal fragments	3	8	<1-113
partially combusted coal	1		
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	13	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	3	4	<1-75
magnetic fragments	17	4	<1-79
titanium dioxide	-		
coke	10	6	<1-170
graphite	<0.5		<1-104
magnetic spheres	21	8	<1-23
slag	-		

PROJECT C8564 SAMPLE NO. 80-405  
MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  250  
REPORT DATE 2/27/81 SAMPLE DATE 07-20-79, FRI  
SITE Washington

       % COMBUSTIBLE 5.6 %  $\text{SO}_4^{=}$  3.2 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	1	12	<1-57
carbonates	17	3	<1-95
clay, humus	10	9	<1-76
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	2	<1-68
coal fragments	2	5	<1-125
partially combusted coal	1	2	<1-147
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	12	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	2	2	<1-24
magnetic fragments	18	4	<1-92
titanium dioxide	-		
coke	17	9	<1-102
graphite	1	100	<1-329
magnetic spheres	17	5	<1-57
slag	-		

PROJECT C8564 SAMPLE NO. 80-406  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  262  
 REPORT DATE 2/27/81 SAMPLE DATE 08-07-79, TUES  
 SITE Washington

       % COMBUSTIBLE 7.3 %  $\text{SO}_4^{=}$  1.6 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	3	13	<1-45
carbonates	10	3	<1-76
clay, humus	7	9	<1-68
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	0.5	25	<1-126
<u>COMBUSTION SOURCES</u>			
glassy flyash	1	5	<1-69
coal fragments	<0.5	8	<1-51
partially combusted coal	1	2	<1-102
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	12	NA	NA
oil soot	-		
<u>BIOLOGICALS</u>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	2	14	6-20
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	1	3	<1-66
magnetic fragments	29	4	<1-273
titanium dioxide	-		
coke	3	6	<1-68
graphite	<0.5		
magnetic spheres	29	6	<1-25
slag	<0.5		

PROJECT C8564 SAMPLE NO. 80-407  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  247  
 REPORT DATE 2/27/81 SAMPLE DATE 08-08-79, TUES  
 SITE Washington

       % COMBUSTIBLE 8.4 %  $\text{SO}_4^{=}$  1.6 %  $\text{NO}_3^{-}$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	3	14	<1-70
carbonates	11	2	<1-88
clay, humus	8	12	<1-45
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		<1-79
<b>COMBUSTION SOURCES</b>			
glassy flyash	2	3	<1-42
coal fragments	<0.5		<1-63
partially combusted coal	1	2	
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	14	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	3	12	6-20
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	1	2	<1-59
magnetic fragments	28	3	<1-54
titanium dioxide	-		
coke	2	6	<1-93
graphite	<0.5		
magnetic spheres	25	5	<1-40
slag	<0.5		<1-72

PROJECT C8564 SAMPLE NO. 80-408  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  294  
 REPORT DATE 2/27/81 SAMPLE DATE 09-06-79, THURS  
 SITE Washington

       % COMBUSTIBLE 8.8 %  $\text{SO}_4^{=}$  2.3 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	3	15	<1-63
carbonates	12	4	<1-58
clay, humus	7	7	<1-45
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	3	<1-30
coal fragments	1	9	<1-87
partially combusted coal	1	2	
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	15	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	1	3	<1-42
magnetic fragments	25	4	<1-74
titanium dioxide	-		
coke	8	6	<1-233
graphite	<0.5		<1-114
magnetic spheres	25	6	<1-35
slag	-		

PROJECT C8564 SAMPLE NO. 80-409  
MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  398  
REPORT DATE 2/27/81 SAMPLE DATE 09-06-79, THURS  
SITE Washington

       % COMBUSTIBLE 12.1 %  $\text{SO}_4^{=}$  2.9 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	1	14	<1-80
carbonates	11	3	<1-88
clay, humus	8	9	<1-79
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	4	<1-34
coal fragments	0.5	6	<1-66
partially combusted coal	1	1	
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	20	NA	NA
oil soot	<0.5		<1-42
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	1	2	<1-34
magnetic fragments	28	4	<1-77
titanium dioxide	-		
coke	6	4	<1-147
graphite	<0.5		
magnetic spheres	22	9	<1-26
slag	-		

PROJECT C8564 SAMPLE NO. 80-410  
MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  282  
REPORT DATE 2/27/81 SAMPLE DATE 09-27-79, THURS  
SITE Washington

       % COMBUSTIBLE 11.5 %  $\text{SO}_4^{=}$  4.0 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	0.5	12	<1-84
carbonates	9	3	<1-45
clay, humus	4	7	<1-68
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	3	<1-31
coal fragments	<0.5		
partially combusted coal	1	2	
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	21	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	1	1	<1-27
magnetic fragments	55	4	<1-124
titanium dioxide	-		
coke	4	9	<1-110
graphite	<0.5		
magnetic spheres	3	8	<1-21
slag	-		

PROJECT C8564 SAMPLE NO. 80-411  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  287  
 REPORT DATE 2/27/81 SAMPLE DATE 10-12-79, SAT  
 SITE Washington

       % COMBUSTIBLE 6.2 %  $\text{SO}_4^{=}$  0.9 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	2	15	<1-35
carbonates	10	3	<1-79
clay, humus	4	9	<1-82
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5		<1-45
coal fragments	2	6	<1-85
partially combusted coal	1	2	
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	10	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	10	2	<1-38
magnetic fragments	47	4	<1-86
titanium dioxide	-		
coke	10	10	<1-120
graphite	<0.5		<1-113
magnetic spheres	3	6	<1-20
slag	-		

PROJECT C8564 SAMPLE NO. 80-423  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  230  
 REPORT DATE 2/27/81 SAMPLE DATE 03-10-79, SAT  
 SITE Addams

       % COMBUSTIBLE 10.9 %  $\text{SO}_4^{=}$  1.0 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	1	9	<1-57
carbonates	14	4	<1-51
clay, humus	2	10	<1-79
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<u>COMBUSTION SOURCES</u>			
glassy flyash	<0.5	4	<1-23
coal fragments	1	6	<1-65
partially combusted coal	<0.5		
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	11	NA	NA
oil soot	-		
<u>BIOLOGICALS</u>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	6	1	<1-31
magnetic fragments	50	2	<1-88
titanium dioxide	-		
coke	4	6	<1-136
graphite	<0.5	35	<1-159
magnetic spheres	10	6	<1-20
slag	-		

PROJECT C8564 SAMPLE NO. 80-424  
MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  200  
REPORT DATE 2/27/81 SAMPLE DATE 03-22-79, THURS  
SITE Addams

       % COMBUSTIBLE 9.8 %  $\text{SO}_4^{=}$  2.0 %  $\text{NO}_3^{-}$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	2	12	<1-71
carbonates	18	3	<1-72
clay, humus	13	10	<1-68
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		<1-108
<b>COMBUSTION SOURCES</b>			
glassy flyash	15	4	<1-58
coal fragments	5		<1-87
partially combusted coal	1	2	<1-80
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	16	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	2	2	<1-22
magnetic fragments	10	4	<1-35
titanium dioxide	-		
coke	15	9	<1-147
graphite	<0.5		
magnetic spheres	<0.5		
slag	-		

PROJECT C8564SAMPLE NO. 80-425MICROSCOPIST KGSTSP,  $\mu\text{g}/\text{m}^3$  93REPORT DATE 2/27/81SAMPLE DATE 04-12-79, THURSSITE Addams       % COMBUSTIBLE10.0 %  $\text{SO}_4^{=}$ 2.6 %  $\text{NO}_3^-$ 

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	2	16	<1-59
carbonates	25	4	<1-96
clay, humus	10	10	<1-56
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	1	30	<1-143
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	4	<1-26
coal fragments	0.5	6	<1-54
partially combusted coal	0.5		
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	17	NA	NA
oil soot	<0.5		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	3		
plant parts	1		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	1	2	<1-30
magnetic fragments	30	6	<1-40
titanium dioxide	-		
coke	5	10	<1-91
graphite	<0.5		<1-106
magnetic spheres	3	5	<1-21
slag	-		

PROJECT C8564 SAMPLE NO. 80-426  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  56  
 REPORT DATE 2/27/81 SAMPLE DATE 05-21-79, MON  
 SITE Addams

       % COMBUSTIBLE 8.3 %  $\text{SO}_4^{=}$  1.0 %  $\text{NO}_3^{-}$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	17	18	<1-83
carbonates	17	4	<1-45
clay, humus	14	12	<1-57
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	2	25	<1-191
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	3	<1-41
coal fragments	<0.5		
partially combusted coal	1	2	<1-112
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	13	NA	NA
oil soot	<0.5		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	5		
plant parts	2		
insect fragments	<0.5		
plant tissue	<0.5		
starch	1		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	1	1	<1-34
magnetic fragments	24	8	<1-29
titanium dioxide	-		
coke	2	6	<1-91
graphite	<0.5		<
magnetic spheres	<0.5		
slag	-		

PROJECT C8564SAMPLE NO. 80-427MICROSCOPIST KGSTSP,  $\mu\text{g}/\text{m}^3$  36REPORT DATE 2/27/81SAMPLE DATE 07-17-79, TUESSITE Addams       % COMBUSTIBLE10.8 %  $\text{SO}_4^{=}$ 1.3 %  $\text{NO}_3^-$ 

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	1	10	<1-35
carbonates	15	3	<1-74
clay, humus	7	10	<1-70
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	2	<1	<1
rubber tire fragments	2	25	<1-76
<u>COMBUSTION SOURCES</u>			
glassy flyash	<0.5	3	<1-18
coal fragments	1	8	<1-77
partially combusted coal	5	4	
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	17	NA	NA
oil soot	<0.5		
<u>BIOLOGICALS</u>			
pollens, spores, conidia	<0.5		
plant parts	1		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	3	3	<1-47
magnetic fragments	44	7	<1-45
titanium dioxide	-		
coke	2	6	<1-108
graphite	<0.5		
magnetic spheres	<0.5		
slag	-		

PROJECT C8564 SAMPLE NO. 80-428  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  193  
 REPORT DATE 2/27/81 SAMPLE DATE 08-13-79, MON  
 SITE Addams

       % COMBUSTIBLE 11.0 %  $\text{SO}_4^{=}$  2.5 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	1	12	<1-61
carbonates	16	4	<1-68
clay, humus	8	9	<1-45
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	3	<1-36
coal fragments	<0.5		
partially combusted coal	1	2	<1-142
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	18	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	1		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	3	2	<1-25
magnetic fragments	25	3	<1-45
titanium dioxide	-		
coke	16	2	<1-136
graphite	<0.5		
magnetic spheres	9	4	<1-25
slag	-		

PROJECT C8564SAMPLE NO. 80-429MICROSCOPIST KGSTSP,  $\mu\text{g}/\text{m}^3$  109REPORT DATE 2/27/81SAMPLE DATE 08-22-79, WEDSITE Addams       % COMBUSTIBLE27.9 %  $\text{SO}_4^{=}$ 5.9 %  $\text{NO}_3^-$ 

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	1	12	<1-45
carbonates	13	5	<1-167
clay, humus	5	12	<1-103
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	1	25	<1-111
<u>COMBUSTION SOURCES</u>			
glassy flyash	<0.5	4	<1-25
coal fragments	0.5		<1-118
partially combusted coal	0.5		
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	46	NA	NA
oil soot	<0.5		
<u>BIOLOGICALS</u>			
pollens, spores, conidia	3		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	3		
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	1	2	<1-29
magnetic fragments	7	8	<1-83
titanium dioxide	-		
coke	15	3	<1-148
graphite	<0.5		<1-136
magnetic spheres	4	5	<1-18
slag	-		

PROJECT C8564 SAMPLE NO. 80-430  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  214  
 REPORT DATE 2/27/81 SAMPLE DATE 09-12-79, WED  
 SITE Addams

       % COMBUSTIBLE      20.7 %  $\text{SO}_4^{=}$       5.4 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	1	16	<1-76
carbonates	15	4	<1-66
clay, humus	22	13	<1-57
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	2	<1-33
coal fragments	0.5	8	<1-144
partially combusted coal	1	2	<1-198
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	36	NA	NA
oil soot	-		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	1	2	<1-45
magnetic fragments	15	4	<1-79
titanium dioxide	-		
coke	7	13	<1-159
graphite	<0.5		<1-177
magnetic spheres	<0.5		<1-117
slag	<0.5		

PROJECT C8564 SAMPLE NO. 80-431  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  220  
 REPORT DATE 2/27/81 SAMPLE DATE 09-27-79 THURS  
 SITE Addams

       % COMBUSTIBLE 14.8 %  $\text{SO}_4^{=}$  4.3 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	1	12	<1-46
carbonates	7	4	<1-68
clay, humus	7	13	<1-113
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5		<1-316
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5		<1-58
coal fragments	<0.5		
partially combusted coal	2	2	<1-151
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	26	NA	NA
oil soot	<0.5		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	0.5		
plant parts	2		
insect fragments	<0.5		
plant tissue	<0.5		
starch	<0.5		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	1	2	<1-73
magnetic fragments	47	7	<1-156
titanium dioxide	-		
coke	5	8	<1-208
graphite	<0.5	80	<1-287
magnetic spheres	<0.5		
slag	-		

PROJECT C8564 SAMPLE NO. 80-432  
 MICROSCOPIST KGS TSP,  $\mu\text{g}/\text{m}^3$  205  
 REPORT DATE 2/27/81 SAMPLE DATE 10-30-79, TUES  
 SITE Addams

       % COMBUSTIBLE 9.2 %  $\text{SO}_4^{=}$  3.8 %  $\text{NO}_3^-$

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<b>MINERALS</b>			
quartz, feldspars	2	13	<1-79
carbonates	20	4	<1-105
clay, humus	22	11	<1-93
other	<0.5		
pavement	<0.5		
<b>MOBILE SOURCES</b>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	<0.5	25	
<b>COMBUSTION SOURCES</b>			
glassy flyash	<0.5	3	<1-29
coal fragments	5	9	<1-307
partially combusted coal	2	1	<1-117
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	18	NA	NA
oil soot	<0.5		
<b>BIOLOGICALS</b>			
pollens, spores, conidia	<0.5		
plant parts	<0.5		
insect fragments	<0.5		
plant tissue	<0.5		
starch	3		
<b>MISCELLANEOUS</b>			
non-magnetic iron and oxides	4	2	<1-79
magnetic fragments	15	6	<1-34
titanium dioxide	-		
coke	8	8	<1-137
graphite	<0.5		<1-319
magnetic spheres	<0.5		
slag	<0.5		

PROJECT C8564SAMPLE NO. 80-433MICROSCOPIST KGSTSP,  $\mu\text{g}/\text{m}^3$  95REPORT DATE 2/27/81SAMPLE DATE 11-05-79, MONSITE Addams       % COMBUSTIBLE11.8 %  $\text{SO}_4^{=}$ 6.9 %  $\text{NO}_3^-$ 

COMPONENTS	CONCENTRATION WEIGHT %	GEOMETRIC SIZE, $\mu\text{m}$	
		MEAN	RANGE
<u>MINERALS</u>			
quartz, feldspars	7	18	<1-51
carbonates	15	4	<1-68
clay, humus	15	9	<1-122
other	<0.5		
pavement	<0.5		
<u>MOBILE SOURCES</u>			
tailpipe exhaust	1	<1	<1
rubber tire fragments	1	25	<1-105
<u>COMBUSTION SOURCES</u>			
glassy flyash	<0.5	3	<1-48
coal fragments	1	14	<1-130
partially combusted coal	1	1	<1-213
fine carbonaceous particles	<0.5	<1	<1
ammonium sulfate and nitrate	25	NA	NA
oil soot	-		
<u>BIOLOGICALS</u>			
pollens, spores, conidia	1		
plant parts	1		
insect fragments	<0.5		
plant tissue	<0.5		
starch	1		
<u>MISCELLANEOUS</u>			
non-magnetic iron and oxides	<0.5	1	<1-113
magnetic fragments	25	9	<1-45
titanium dioxide	-		
coke	1	6	<1-164
graphite	<0.5		<1-137
magnetic spheres	5	6	<1-23
slag	<0.5		<1-91



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Source contributions to TSP non-attainment



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